TRANSACTIONS

OF THE

KANSAS ACADEMY OF SCIENCE

(Founded in 1868)

VOLUME 39

F. C. GATES, *Editor*
W. J. BAUMGARTNER, *Managing Editor*

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EMPORIA, KAN.

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CONSTITUTION AND BYLAWS

CONSTITUTION *

SECTION 1. This association shall be called the Kansas Academy of Science.

SEC. 2. The objects of this Academy shall be to increase and diffuse knowledge in various departments of science.

SEC. 3. The membership of this Academy shall consist of three classes: annual, life and honorary.

(1) Annual members may be elected at any time by the committee on membership, which shall consist of the secretary and other members appointed, annually, by the president. Annual members shall pay annual dues of one dollar, but the secretary and treasurer shall be exempt from the payment of dues during the years of their service.

(2) Any person who shall have paid thirty dollars in annual dues, or equivalent due to legal exemption, or in one sum, or in any combination, may be elected to life membership, free of assessment, by a two-thirds vote of the members present at an annual meeting.

(3) Honorary members may be elected because of special prominence in science upon written recommendation of two members of the Academy, by a two-thirds vote of the members present. Honorary members pay no dues.

SEC. 4. The officers of this Academy shall be chosen by ballot at the annual meeting, and shall consist of a president, two vice-presidents, a secretary and a treasurer, who shall perform the duties usually pertaining to their respective offices. The president, the secretary and the treasurer shall consitute the executive committee. The secretary shall be in charge of all the books, collections and material property belonging to the Academy.

SEC. 5. Unless otherwise directed by the Academy, the annual meeting shall be held at such time and place as the executive committee shall designate. Other meetings may be called at the discretion of the executive committee.

SEC. 6. This constitution may be altered or amended at any annual meeting by a vote of three fourths of attending members of at least one year's standing. No question of amendment shall be decided on the day of its presentation.

SEC. 7. This Academy shall have an executive council consisting of the president, the secretary, the treasurer, the vice-presidents, the chairmen of the sections and the retiring president, and other members to be nominated by the nominating committee and elected as the other officers. This council shall have general oversight of the Academy not otherwise given by this Constitution to officers or committees.

SEC. 8. This Academy shall have an editorial board consisting of an editor, a managing editor, and four associate editors. These members shall be elected

* As modified by amendments.

in the same manner as other officers, but for a period of three years. Two members of the board shall be elected every year, except that in 1935 the editor and one associate shall be elected for three years, the managing editor and one associate for two years and two associates for one year each.

The editor, with the aid of the associate editors, shall have general supervision of all editorial work submitted for publication in the Transactions, and shall be responsible for the selecting, editing, revision and rejection of papers submitted for publication. The managing editor shall be responsible for the making of the plates and the printing and general distribution of the Transactions.

BYLAWS

I. At the beginning of each annual session there shall be held a brief business meeting for announcements and appointment of committees. For the main business meeting, held later in the session, the following order is suggested:

1. Reports of officers.
2. Reports of standing committees.
3. Unfinished business.
4. New business.
5. Reports of special committees.
6. Election of officers.
7. Election of life and honorary members.

II. The president shall deliver a public address on the evening of one of the days of the meeting, at the expiration of his term of office.

III. No meeting shall be held without a notice of the same having been published in the papers of the state at least thirty days previous.

IV. No bill against the Academy shall be paid by the treasurer without an order signed by the president and secretary.

V. Names of members more than one year in arrears in dues shall be dropped from the membership list.

VI. The secretary shall have charge of the distribution, sale and exchange of the published Transactions of the Academy, under such restrictions as may be imposed by the executive committee.

VII. Ten percent of the active membership shall constitute a quorum for the transaction of business. Section meetings may not be scheduled or held at the time a business meeting is called by the president at a general session or announced on the program.

VIII. The time allotted to the presentation of a single paper shall not exceed fifteen minutes.

IX. No paper shall be entitled to a place on the program unless the manuscript, or an abstract of the same, shall have been previously delivered to the secretary.

X. Section programs may be arranged by the secretary with the advice of the section chairmen. The subdivision or combination of existing sections shall be dependent upon the number of papers to be presented. Such changes shall be made by the secretary in accordance with the policies of the Academy and after receiving the advice of the chairmen of the sections concerned.

XI. Section chairmen for the ensuing year shall be elected annually at the close of the section meetings.

XII. Section programs shall be limited to Friday afternoon of the annual session, but may be continued Saturday afternoon if desired by the section chairman. Exceptions to this must receive the approval of the executive committee.

Year.	President.	First Vice-president.	Second Vice-president.	Secretary.	Treasurer.
1869	B. F. Mudge	J. S. Whitman		J. D. Parker	F. H. Snow
1870	B. F. Mudge	J. S. Whitman		J. D. Parker	F. H. Snow
1871	John Fraser	B. F. Mudge		J. D. Parker	F. H. Snow
1872	John Fraser	B. F. Mudge	R. J. Brown	J. D. Parker	F. H. Snow
1873	John Fraser	B. F. Mudge	R. J. Brown	J. D. Parker	F. H. Snow
1874	F. H. Snow	J. A. Banfield	J. D. Parker	John Wherrell	R. J. Brown
1875	F. H. Snow	B. F. Mudge	J. D. Parker	John Wherrell	R. J. Brown
1876	F. H. Snow	B. F. Mudge	J. H. Carruth	Joseph Savage	R. J. Brown
1877	F. H. Snow	B. F. Mudge	J. H. Carruth	Joseph Savage	R. J. Brown
1878	F. H. Snow	B. F. Mudge	J. H. Carruth	E. A. Popenoe	R. J. Brown
1879	B. F. Mudge	J. H. Carruth	Joseph Savage	E. A. Popenoe	R. J. Brown
1880	B. F. Mudge	J. H. Carruth	Joseph Savage	E. A. Popenoe	R. J. Brown
1881	J. T. Lovewell	J. H. Carruth	Joseph Savage	E. A. Popenoe	R. J. Brown
1882	J. T. Lovewell	J. H. Carruth	Joseph Savage	E. A. Popenoe	R. J. Brown
1883	A. H. Thompson	J. R. Mead	G. E. Patrick	E. A. Popenoe	R. J. Brown
1884	R. J. Brown	F. H. Snow	Joseph Savage	E. A. Popenoe	A. H. Thompson
1885	R. J. Brown	E. L. Nichols	G. H. Failyer	E. A. Popenoe	A. H. Thompson
1886	E. L. Nichols	J. D. Parker	N. S. Goss	E. A. Popenoe	I. D. Graham
1887	J. D. Parker	J. R. Mead	E. H. S. Bailey	E. A. Popenoe	I. D. Graham
1888	J. R. Mead	E. H. S. Bailey	T. H. Dinsmore, Jr.	E. A. Popenoe	I. D. Graham
1889	T. H. Dinsmore, Jr.	E. H. S. Bailey	G. H. Failyer	E. A. Popenoe	I. D. Graham
1890	G. H. Failyer	D. S. Kelly	F. W. Gragin	E. H. S. Bailey	I. D. Graham
1891	Robert Hay	F. W. Cragin	O. C. Charlton	E. H. S. Bailey	F. O. Marvin
1892	E. A. Popenoe	F. O. Marvin	Mrs. N. S. Kedzie,	E. H. S. Bailey	D. S. Kelly
1893	E. H. S. Bailey	J. T. Willard	E. B. Kneer	A. M. Collete	D. S. Kelly
1894	L. E. Sayre	I. D. Graham	J. L. Howitt	E. B. Kneer	D. S. Kelly
1895	Warren Knaus	I. D. Graham	S. W. Williston	E. B. Kneer	D. S. Kelly
1896	D. S. Kelly	S. W. Williston	D. E. Lantz	E. B. Kneer	L. E. Sayre
1897	S. W. Williston	D. E. Lantz	A. S. Hicthcock	E. B. Kneer	J. W. Beede
1898	D. E. Lantz	C. S. Parmenter	L. C. Wooster	E. B. Kneer	J. W. Beede
1899	E. B. Kneer	A. S. Hitchcock	J. R. Mead	D. E. Lantz	J. W. Beede
1900	A. S. Hitchcock	E. Miller	J. C. Cooper	D. E. Lantz	J. W. Beede
1901	E. Miller	J. C. Cooper	L. C. Wooster	D. E. Lantz	E. C. Franklin
1902	J. T. Willard	Edward Bartow	J. A. Yates	G. P. Grimsley	E. C. Franklin
1903	J. C. Cooper	Edward Bartow	J. A. Yates	G. P. Grimsley	Alva J. Smith
1904	Edward Bartow	L. C. Wooster	B. F. Eyer	G. P. Grimsley	Alva J. Smith
1905	L. C. Wooster	F. W. Bushong	W. A. Harshbarger	J. T. Lovewell	Alva J. Smith
1906	F. O. Marvin	B. F. Eyer	J. E. Welin	J. T. Lovewell	Alva J. Smith
1907	J. A. Yates	E. Haworth	F. B. Dains	J. T. Lovewell	Alva J. Smith
1908	E. Haworth	F. B. Dains	I. M. McWharp	J. T. Lovewell	Alva J. Smith
1909	F. B. Dains	J. M. McWharf	Alva J. Smith	J. T. Lovewell	F. W. Bushong
1910	F. B. Dains	J. M. McWharf	Alva J. Smith	J. T. Lovewell	F. W. Bushong
1911	J. M. McWharf	Alva J. Smith	J. E. Welin	J. T. Lovewell	F. W. Bushong
1912	F. W. Bushong	Alva J. Smith	J. E. Welin	J. T. Lovewell	L. D. Havenhill
1913	Alva J. Smith	W. A. Harshbarger	J. A. G. Shirk	J. T. Lovewell	L. D. Havenhill
1914	W. A. Harshbarger	J. A. G. Shirk	J. E. Todd	J. T. Lovewell	L. D. Havenhill
1915-1916	J. A. G. Shirk	J. E. Todd	F. U. G. Agrelius	J. T. Lovewell	L. D. Havenhill
1916-1917	J. E. Todd	F. U. G. Agrelius	L. D. Havenhill	W. W. Swingle	W.A.Harshbarger
1917-1918	F. U. G. Agrelius	L. D. Havenhill	B. M. Allen	W. W. Swingle	W.A.Harshbarger
				H. W. Swingle	
				Guy West Wilson	
1918-1919	L. D. Havenhill	R. K. Nabours	B. M. Allen	Guy West Wilson	F. C. Bruchmiller
1919-1920	R. K. Nabours	B. M. Allen	O. P. Dellinger	E. A. White	L. D. Havenhill
1920-1921	O. P. Delinger	Roy Rankin	W. P. Hays	E. A. White	L. D. Havenhill
1921-1922	Roy Rankin	R. K. Nabours	W. R. B. Robertson	E. A. White	L. D. Havenhill
1922-1923	R. K. Nabours	H. P. Cady	H. H. Nininger	E. A. White	L. D. Havenhill
1923-1924	H. P. Cady	H. H. Nininger	J. E. Ackert	E. A. White	L. D. Havenhill
1924-1925	H. H. Nininger	J. E. Ackert	F. U. G. Agrelius	E. A. White	L. D. Havenhill
1925-1926	J. E. Ackert	H. M. Elsey	W. M. Goldsmith,	E. A. White	L. D. Havenhill
1926-1927	H. J. Harnly	Mary T. Harman,	L. D. Wooster	E. A. White	L. D. Havenhill
1927-1928	Mary T. Harman,	L. D. Wooster	W. B. Wilson	E. A. White	L. D. Havenhill
1928-1929	L. D. Wooster	W. B. Wilson	Hazel E. Branch	G. E. Johnson	L. D. Havenhill
1929-1930	W. B. Wilson	Hazel E. Branch	W. M. Goldsmith,	G. E. Johnson	R. Q. Brewster
1930-1931	Hazel E. Branch	Roger C. Smith	W. H. Matthews	G. E. Johnson	R. Q. Brewster
1931-1932	Roger C. Smith	W. J. Baumgartner	J. W. Hershey	G. E. Johnson	R. Q. Brewster
1932-1933	Robert Taft	J. W. Hershey	W. H. Matthews	G. E. Johnson	H. A. Zinsser
1933-1934	J. W. Hershey	W. H. Matthews	E. A. Marten	G. E. Johnson	H. A. Zinsser
1934-1935	W. H. Matthews	E. A. Marten	W. J. Baumgartner	G. E. Johnson	H. A. Zinsser
				F. C. Gates.	
1935-1936	W. J. Baumgartner	L. Oncley	H. H. Hall	Roger C. Smith	H. A. Zinsser
1936-1937	L. Oncley	G. A. Dean	W. H. Schoewe	Roger C. Smith	H. A. Zinsser

Note.—Previous to 1931-'32 the secretary was also editor. Since 1931-'32 F. C. Gates has been editor.

PAST OFFICERS OF THE ACADEMY

ABBREVIATIONS: The following abbreviations for institutions have been used:

U. of K.: University of Kansas.
K. S. C.: Kansas State College of Agriculture and Applied Science.
K. S. T. C.: Kansas State Teachers College.
F. H. K. S. C.: Fort Hays Kansas State College.
H. S.: High School.
Jr. H. S.: Junior High School.
Jr. Col.: Junior College.

Other abbreviations follow those used in the Summarized Proceedings of the American Association for the Advancement of Science.

The year given indicates the time of election to membership.

HONORARY MEMBERS

Barber, Marshall A., Ph. D., 1904, Internat. Health Div., Rockefeller Found., 49 W. Forty-ninth street, New York, N. Y.

Cockerell, T. D. A., D. Sc., 1908, prof. zoölogy (emeritus), Univ. Colorado, Boulder, Colo.

Grimsley, G. P., Ph. D., 1896, geological eng., B. & O. R. R., 4405 Underwood Road (Guilford), Baltimore, Md.

Kellogg, Vernon L., LL. D., Sc. D., 1920, permanent secretary emeritus, National Research Council, Washington, D. C. (2305 Bancroft Place.)

McClung, C. E., Ph. D., 1903, dir. zoölogy lab., Univ. Pennsylvania, Philadelphia, Pa.

McCollum, E. V., Ph. D., Sc. D., 1902, prof. biochemistry, Johns Hopkins Univ., Baltimore, Md.

Nichols, Edward L., Ph. D., Sc. D., 1885 (honorary member 1897), prof. physics (emeritus), Cornell Univ., Ithaca, N. Y.

Riggs, Elmer S., M. A., 1896, assoc. curator paleontology, Field Mus. Nat. Hist., Chicago, Ill.

Wagner, George, M. A., 1897 (honorary member 1904), prof. zoölogy, Univ. Wisconsin, Madison, Wis.

LIFE MEMBERS

Agrelius, Frank U. G., M. A., 1905, assoc. prof. biol., K. S. T. C., Emporia, Kan.

Allen, Herman Camp, Ph. D., 1904, prof. chemistry, U. of K., Lawrence, Kan.

Bartow, Edward, Ph. D., Sc. D., 1897, prof. and head Dept. Chem. and Chem. Eng., State Univ. Iowa, Iowa City, Iowa.

Baumgartner, William J., Ph. D., 1904, prof. zoölogy, U. of K., Lawrence, Kan.

Beede, Joshua W., Ph. D., 1894, prof. geology and paleontology, Indiana Univ., Bloomington, Ind.

Berry, Sister M. Sebastion, A. B., 1911, Supt. Schools, St. Paul, Kan.

Bushnell, Leland D., Ph. D., 1908, prof. and head Bacteriology Dept., K. S. C., Manhattan, Kan.

Bushong, F. W., Sc. D., 1896, 2636 Fifth street, Port Arthur, Tex.

Cady, Hamilton P., Ph. D., 1904, prof. chemistry, U. of K., Lawrence, Kan.

Cook, W. A., M. S., 1907, real estate business, 1414 Highland street, Salina, Kan.

Copley, Rev. John T., 1903, Olathe, Kan.

Cragin, F. W., Ph. D., 1880, 912 Miguel street, Colorado Springs, Colo.

Dains, Frank Burnett, Ph. D., 1902, prof. chemistry, U. of K., Lawrence, Kan.

Deere, Emil O., M. S., 1905, dean and prof. biology, Bethany Col., Lindsborg, Kan.

Dellinger, Orris P., Ph. D., 1909, prof. biology, K. S. T. C., Pittsburg, Kan.

Dunlevy, R. B., M. A., 1896, Southwestern Col., Winfield, Kan.

Eby, J. Whit, B. S., 1903, banker, Howard, Kan.

Failyer, George H., M. S., 1878, retired, R. R. 4, Manhattan, Kan.

Faragher, Warren F., Ph. D., 1927, asst. chief, Research Dept., Vacuum Oil Co., Inc., Paulsboro, N. J.

MEMBERSHIP OF THE ACADEMY

May 25, 1936

Garrett, A. O., M. A., 1901, head Dept. Biology, East High School, Salt Lake City, Utah.
Graham, I. D., M. S., 1879, State Board of Agric., Topeka, Kan.
Harman, Mary T., Ph. D., 1912, prof. zoölogy, K. S. C., Manhattan, Kan.
Harnly, Henry J., Ph. D., 1893, prof. biology, McPherson Col., McPherson, Kan.
Harshbarger, William A., Sc. D., 1903, prof. mathematics, Washburn Col., Topeka, Kan.
Havenhill, L. D., Ph. C., 1904, dean School of Pharmacy, U. of K., Lawrence, Kan.
King., H. H., Ph. D., 1909, prof. and head Dept. Chemistry, K. S. C., Manhattan, Kan.
Knaus, Warren M., D. Sc., 1882, entomologist, editor *Democrat Opinion,* McPherson, Kan.
McWharf, J. M., M. D., 1902, 715 Princeton St., Ottawa, Kan.
Meeker, Grace R., 1899, 709 S. Mulberry, Ottawa, Kan.
Menninger, C. F., M. D., 1903, 3617 W. Sixth avenue, Topeka, Kan.
Nabours, Robert K., Ph. D., 1910, prof. and head Zoölogy Dept., K. S. C., Manhattan, Kan.
Nissen, A. M., A. B., 1888, farmer, Wetmore, Kan.
Peace, Larry M., 1904, 512 W. Ninth street, Lawrence, Kan.
Reagan, Albert B.,† Ph. D., 1904, 139 E. Fourth N., Provo, Utah.
Robertson, W. R. B., Ph. D., 1905, Anat. Dept., Univ. Iowa, Iowa City, Iowa.
Schaffner, John H., M. S., 1903, research and prof. botany, Ohio State Univ., Columbus, Ohio.
Scheffer, Theodore, M. A., 1903, assoc. biologist, U. S. Biological Survey, Puyallup, Wash.
Shirk, J. A. G., 1904, prof. mathematics, K. S. T. C., Pittsburg, Kan.
Smith, Alva J., 1892, consulting eng., 810 Boylston street, Pasadena, Cal.
Smyth, E. Graywood, 1901, entomologist, Cia. Agricola Carabayllo, Hacienda Cartavio, Trujillo, Peru.
Smyth, Lumina C. R., Ph. D., 1902, 16802 Dartmouth, Cleveland, Ohio.
Sterling, Charles M., A. B., 1904, Lawrence, Kan. (Deceased.)
Sternberg, Charles H., M. A., 1896, 4046 Arizona street, San Diego, Cal.
Stevens, Wm. C., 1890, head Botany Dept., U. of K., Lawrence, Kan.
Welin, John Eric., D. Sc., 1889, prof. chemistry, Bethany Col., Lindsborg, Kan.
White, E. A., M. A., 1904, prof. chemistry, U. of K., Lawrence, Kan.
Willard, Julius T., D. Sc., 1883, vice-president K. S. C., Manhattan, Kan.
Wilson, William B., Sc. D., 1903, head Biology Dept., Ottawa Univ., Ottawa, Kan.
Wooster, Lyman C., Ph. D., 1889, prof. biology and geology (emeritus), K. S. T. C., Emporia, Kan.

ANNUAL MEMBERS

Members who paid their 1936 dues before May 23, 1936, are indicated by an asterisk (*). The year given is that of election to membership. If two years are given the second signifies reëlection.

*Ackert, James E., Ph. D., 1919, prof. zoöl., parasitologist, dean Graduate Div., K. S. C., Manhattan, Kan.
Adams, Myrl R., M. A., 1935, Jones-Dabney Co., Louisville, Ky.
*Aicher, L. C., B. S., 1930, supt. Fort Hays Branch, K. S. A. Expt. Sta., Hays, Kan.
Albertson, F. W., 1935, assoc. prof. agr., F. H. K. S. C., Hays, Kan.
*Albright, Penrose S., M. S., 1926, asst. prof. physics and chem., Southwestern Col., Winfield, Kan.
Allegre, Charles, 1935, K. S. T. C., Emporia, Kan.
*Allen, Evelyn Helen, 1936, U. of K., Lawrence, Kan.
*Aller, Alvin R., M. S., 1932, 607 E. Sixteenth street, Hutchinson, Kan.
*Alm, O. W., Ph. D., 1931, assoc. prof. psych., K. S. C., Manhattan, Kan.
Alsop, M. L., M. S., 1932, teacher, H. S., Wamego, Kan.
*Angell, Wenonah E., 1936, K. S. T. C., Emporia (Medicine Lodge), Kan.
Arnold, Stattlar, B. S., 1935, teacher, Neosho Rapids, Kan.
*Askren, Edward L., Jr., 1936, 1220 Moro street, Manhattan, Kan.
*Aubel, C. E., Ph. D., 1933, assoc. prof. animal husbandry, K. S. C., Manhattan, Kan.
*Ayers, H. D., Ph. D., 1928, head Dept. Physics, Univ. Wichita, Wichita, Kan.
*Ayers, Jane L., A. B., 1935, asst. botany, Washburn Col., Topeka, Kan.
*Ayers, John C., A. B., 1936, Dept. Zoöl., K. S. C., Manhattan, Kan.
*Babcock, Rodney W., Ph. D., 1931, dean, Div. Gen. Sci., K. S. C., Manhattan, Kan.
*Baden, Martin W., Sc. D., 1921, Box 520, Winfield, Kan.

† Deceased May 30, 1936.

*Bartholic, Robert L., A. B., F. H. K. S. C., (R. No. 1), Hays, Kan.
Baker, Burton L., A. B., 1934, Columbia, U., New York, N Y.
*Bardo. Carol, A. B., 1933, lab. technician, Suite 14, Arcade Bldg., Arkansas City, Kan.
Barham, Harold N., Ph. D., 1931, assoc. prof. chem., K. S. C., Manhattan, Kan.
*Barnett, R. J., M. S., 1922, prof, hort., K. S. C., Manhattan, Kan.
Barnhart, Carl, B. S., 1932, instr. H. S. East, Wichita, Kan.
*Barton, A. W., Ph. D., 1928, head Dept. Botany, F. H. K. S. C., Hays, Kan.
*Bates, James, M. A., 1933, instr. botany, K. S. C., Manhattan, Kan.
*Bayles, Ernest E., M. A., 1936, assoc. prof, educ., U. of K., Lawrence, Kan.
*Beach, Edith, M. A., 1931, 812 Illinois street, Lawrence, Kan.
*Beamer, Raymond H., Ph. D., 1936, Dept. Ent., U. of K., Lawrence, Kan.
Beaudry, David P., Sr., Santa Fe Railway Reptile Club, 708 Topeka avenue, Topeka, Kan.
*Beck, James Theodore, M. A., 1936, instr. Lane College, Jackson, Tenn.
*Bell, John W., B. S., 1935, instr. ind. arts, H. S., Walton, Kan.
Benne, Kenneth, B. S., 1933, science teacher, H. S., Manhattan, Kan.
*Bennett, Dewey, M. A., 1928, instr. biol. and chem., Jr. Col., Garden City, Kan.
*Black, Paul E., 1933, U. of K., Lawrence, Kan. (Olathe, Kan.)
*Blackman, L. E., Ph. D., 1935, head Dept. Chemistry, K. S. T. C., Emporia, Kan.
*Bogart, Ralph, B. S., 1936, Dept. Animal Husbandry, K. S. C., Manhattan, Kan.
Bond, Glenn, C., M. A., 1935, asst. instr. bact., U. of K., Lawrence, Kan.
*Borman, Ina M., M. A., 1936, instr. 902 Congress, Emporia, Kan.
*Boughton, L. L., M. S., 1929, asst. prof. pharmacy, U. of K., Lawrence, Kan.
*Bowman, J. L., M. S., 1928, head Dept. Math. and Physics, McPherson Col., McPherson, Kan.
Boyce, Ernest, M. S., 1935, prof. civil engr., U. of K., Lawrence, Kan.
*Branch, Hazel E., Ph. D., 1924, head Dept. Zoöl., U. of Wichita, Wichita, Kan.
*Brennan, L. A., M. S., 1933, Andale, Kan.
*Breukelman, John, Ph. D., 1930, prof. biol., K. S. T. C., Emporia, Kan.
*Brewster, Ray Q., Ph. D., 1919, prof. chem., U. of K., Lawrence, Kan.
Brigden, Robert L., 1931, Wichita Child Res. Lab., Wichita, Kan.
*Briscoe, Florence, 1935, U. of K., Lawrence, Kan.
Brooks, Charles H., M. S., 1929, Extension Div., F. H. K. S. C., Hays, Kan.
*Brown, Edwin J., Ph. D., 1936, dir., grad. div., K. S. T. C., Emporia, Kan.
*Brown, Harold P., Ph. D., 1934, prof, chem., U. of K. C., Kansas City, Mo.
Brown, J. F., Ph. D., 1933, asst. prof. psy., U. of K., Lawrence, Kan.
*Brubaker, H. W., Ph. D., 1929, prof. chem., K. S. C., Manhattan, Kan.
*Bryan, Aldro, 1936, Route 4, Emporia, Kan.
*Bryson, Harry R., M. S., 1933, asst. prof. ento., K. S. C., Manhattan, Kan.
*Burt, Charles E., Ph. D., 1932, prof. biol., Southwestern Col., Winfield, Kan.
*Burt, Roy A., B. S., 1934, geologist, 56th and Shawnee Mission Road, Kansas City, Kan.
Busenbark, Ray, 1935, Jr. Col., Kansas City, Kan.
Cady, Ruth, A. B., 1935, Dept. Bact., U. of K., Lawrence, Kan.
*Call, L. E., M. S., 1922, dean Div. Agr., dir. Agr. Exp. Sta., K. S. C., Manhattan, Kan.
*Campbell, Marion I., M. S., 1929, Topeka State Hospital, Topeka, Kan.
*Carlson, Hjalmar E., M. D., 1932, asst. surgery, U. of K. Med. Sch., 4319 Mission Rd., Kansas City, Kan.
*Carpenter, A. C., 1929, president, Lesh Oil Co., Ottawa, Kan.
Carpenter, Pearl I., M. A., 1935, instr. biol., Liberty Memorial H. S., Lawrence, Kan.
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Swartz, Daphne Bell, M. A., 1935, Bradley College, Peoria, Ill.
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*Talbott, W. A. Jr., 1935, Underhill Terminix Co., Wichita, Kan.
Taylor, Edward H., Ph. D., 1928, assoc. prof. zoöl., U. of K., Lawrence, Kan.
Taylor, Mary Fidelia, A. M., 1930, U. of Chicago, Chicago, Ill.
*Thomas, Lawrence C., Ph. D., 1932, head Dept. Biol., Kansas Wesleyan Univ., Salina, Kan.
*Thompson, D. Ruth, M. A., 1928, prof. chem., Sterling Col., Sterling, Kan.
*Thompson, Rufus H., A. B., 1934, Dept. Bot., U. of K., Lawrence, Kan.
*Tihen, Joe A., 1936, Harper, Kan.
Treece, E. Lee, Ph. D., 1929, assoc. prof. bact., U. of K., Lawrence, Kan.
Trent, J. A., M. A., 1934, asst. prof. biol., K. S. T. C., Pittsburg, Kan.
*Trimmell, John A., M. S., 1936, surveyor, Box 555, Pratt, Kan.
*Turner, Clair K., A. M., 1936, head Dept. Health Educ., K. S. T. C., Emporia, Kan.
Underwood, H. G., Ph. D., 1935, asst. prof. chem., Bethany Col., Lindsborg, Kan.
Van Wormer, Fay, 1936, Osborne, Kan.
*Varvel, Walter A., M. A., 1936, Dept. Psych., U. of K., Manhattan, Kan.
*Voth, Arnold, 1932, teacher, U. of Ariz., Tuscon, Ariz.
*Waring, Sister Mary Grace, Ph. D., 1932, head Dept. Science, Marymount Col., Salina, Kan.
Warner, Robert W., E. E., 1935, prof. elec. engr., U. of K., Lawrence, Kan.
*Warnock, W. G., Ph. D., 1936, asst. prof. math., F. H. K. S. C., Hays, Kan.
*Way, P. Ben, B. S., 1932, teacher H. S., Wichita, Kan.
Weathers, Edra, 1936, child res. lab., Friends Univ., Wichita, Kan.
*Weber, Clement, 1928, Catholic priest, Box 186, Selden, Kan.
*Weber, Louis R., Ph. D., 1929, head Dept. Physics, Friends U., Wichita, Kan.

*Weber, Wallace, B. S., 1936, 1113 Congress, Emporia, Kan.
*Weeks, Elvira, Ph. D., 1927, asst. prof. chem., U. of K., Lawrence, Kan.
*Weidlein, Edward Ray, Sc. D., 1911, dir. Mellon Inst. Ind. Res., Pittsburgh, Pa.
*Welch, Bernard H., 1936, Dept. Zoöl., U. of K., Lawrence, Kan.
*Wells, J. Ralph, Ph. D., 1934, prof. biology, K. S. T. C., Pittsburg, Kan.
Westgate, E. W., 1936, teacher general science.
*Wetmore, Alexander, 1935, U. S. Nat. Museum, Washington, D. C.
*Wheeler, R. H., Ph. D., 1936, head Dept. Psych., U. of K., Lawrence, Kan.
*Whelan, Don B., M. S., Dept. Ento., Col. of Agr., Lincoln, Neb.
*Whitnah, Carroll H., Ph. D., 1936, chemist, K. S. C., Manhattan, Kan.
*Wichita City Library, 1932, Ruth E. Hammond, librarian, Wichita, Kan.
Wichita H. S. East Chemistry Club, 1934, sponsor, Carl Barnhardt, Wichita, Kan.
Wichita H. S. North Science Club, J. A. Glover, Wichita, Kan.
*Wilbur, Donald A., M. A., 1934, asst. prof. ento., K. S. C., Manhattan, Kan.
*Wildish, Myra, A. B., 1936, St. Joseph's Hospital, Kansas City, Mo.
Williams, Chas. C., A. B., 1935, 2612 E. Waterman street, Wichita, Kan.
*Williams, John R., M. S., 1936, K. S. T. C., Emporia, Kan.
*Wimmer, E. J., Ph. D., 1928, asst. prof. zoöl., K. S. C., Manhattan, Kan.
Wismer, C. A., M. S., 1933, Firestone Plantations Co., Monrovia, Liberia, W. Africa.
Wismer, Nettie M., M. S., 1932, science teacher, Jr. H. S., Lawrence, Kan.
*Witherspoon, Ward, A. B., 1936, Jr. Col., Dodge City, Kan.
Wolcott, Grace G., A. B., 1935, instr., 1149 Garfield street, Topeka, Kan.
Wolfson, Chas., M. A., 1935, asst. zoöl., U. of K., Lawrence, Kan.
*Wood, Robert E., M. S., 1930, chemistry, H. S., Lawrence, Kan.
Woodard, Parke, M. D., 1930, asst. prof. phys., U. of K., Lawrence, Kan.
*Wooster, L. D., Ph. M., 1924, prof. zoöl., F. H. K. S. C., Hays, Kan.
*Yoder, J. J., LL. D., 1926, prof. sociol., McPherson Col., McPherson, Kan.
*Young, H. D., 1935, assoc. chemist, U. S. D. A., 1204 Fremont, Manhattan, Kan.
*Zinszer, Harvey A., Ph. D., 1930, prof. physics and astron., F. H. K. S. C., Hays, Kan.
*Zinszer, Richard H., B. S., 1931, 422 W. 12th street, Hays, Kan.
*Zoe, Sister Mary, 1936, chem. instr., St. Mary Col., Leavenworth, Kan.

SIXTY-EIGHTH ANNUAL MEETING

KANSAS ACADEMY OF SCIENCE

Kansas State Teachers College, Emporia, Kan., April 2, 3, 4, 1936

OFFICERS OF THE ACADEMY

W. J. Baumgartner, Lawrence....President
L. Oncley, Winfield....First Vice-president
H. H. Hall, Pittsburg....Second Vice-president
Roger C. Smith, Manhattan....Secretary
H. A. Zinszer, Hays....Treasurer

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W. H. Schoewe, Lawrence
Wm. H. Matthews, Pittsburg
E. A. Martin, Wichita

Chairman of Sections

L. E. Melchers, Botany
C. H. Whitnah, Chemistry
Kathleen Doering, Entomology
H. A. Zinszer, Physics
Bert Nash, Psychology
J. E. Ackert, Zoölogy
Hazel Branch, Junior Academy

EDITORIAL BOARD

F. C. Gates, Editor, Manhattan. Term expires, 1938.
W. J. Baumgartner, Managing Editor. Term expires, 1937.

Associate Editors

E. O. Deere, Lindsborg. Term expires, 1939.
W. W. Floyd, Ottawa. Term expires, 1939.
Robt. Taft, Lawrence. Term expires, 1938.
G. A. Kelly, Hays. Term expires, 1937.

STANDING COMMITTEES

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H. A. Zinszer, Hays, Chairman
W. E. Grimes, Manhattan
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2. Committee on Natural Areas and Ecology

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W. H. Horr, Lawrence
W. A. Matthews, Pittsburg
L. D. Wooster, Hays

3. Junior Academy

Hazel E. Branch, University of Wichita, Wichita
Assisted by members selected by Dr. Branch

4. Coördination of Scientific Groups

Committee not appointed. The work of this committee was under the supervision of the executive committee during 1935-'36.

5. Committee on State Aid

W. J. Baumgartner, Chairman
W. H. Matthews, Pittsburg
F. U. G. Agrelius, Emporia

6. Committee on Membership

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8. Committee on Arrangements for Emporia Meeting

F. U. G. Agrelius, Emporia
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10. Auditing Committee

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11. Resolutions Committee

H. E. Crow, Wichita
J. C. Bates, Manhattan
R. K. Nabours, Manhattan

GENERAL PROGRAM

Thursday, April 2

8:00 p. m. Address: "The Practical Use of Insects for the Control of Insect Pests and Noxious Weeds," by George A. Dean, Head Department of Entomology, Kansas State College, Manhattan. Music Hall Auditorium.

Friday, April 3

9:00 a. m. General Session, Science Hall, room 5.

11:00 a. m. Sound film, "The Human Adventure," a record of archeological investigations of the Oriental Institute of the University of Chicago. Granada Theater. Free to members of the Academy and guests.

1:00 p. m. Demonstration and exhibits in rooms 106, 205, and 208 of the Science Hall.

1:30 p. m. Section programs:

- Botany, Science Hall, room 108.
- Chemistry, Science Hall, room 102, 1:30—3 p. m.
- Junior Academy, Roosevelt High School Assembly room.
- Physics, Science Hall, room 104, 3:00—5 p. m.
- Psychology, Administration building, room 208.
- Zoölogy, Science Hall, room 5.

5:30 p. m. Banquet, Memorial Union ballroom. Toastmaster, L. Oncley, Professor of Chemistry, Southwestern College.
Address of Welcome, Thomas W. Butcher, President of the Kansas State Teachers College of Emporia.
Presidential Address: "The Cell in Growth and Development."
W. J. Baumgartner, Professor of Zoölogy, University of Kansas, Lantern.
8:00 p. m. Address: "Glimpses of the Orient," William Allen White. Albert Taylor Hall, Administration building.

SATURDAY, APRIL 4

8:15 a. m. General session and business.
9:00—10:00 a. m. General business meeting of the Academy.
10:00 a. m. Entomology papers, Science hall, room 104.
Zoölogy Section Continued, Science hall, room 108.
Psychology Section Continued, Administration building, room 208.
12:00 noon. Meeting of the new executive council.
1:30 p. m. Entomology papers, Science hall, room 104.

PAPERS SUBMITTED FOR THE SIXTY-EIGHTH ANNUAL MEETING

GENERAL PAPERS

Friday, April 3, 9 to 11 a. m., Science Hall, Room 5
Chairman: PROF. W. J. BAUMGARTNER

1. Termites. Motion picture. W. A. Talbott, Underhill Terminix Company, Wichita.
2. The Study of Geology, Its Value. Lyman C. Wooster, Emporia.
3. The Bromine and Iodine Content of the Subsurface Waters of Russell, Ellis and Trego Counties, Kansas. H. Everett Runyon and Roy Rankin, F. H. K. S. C.
4. A Preserve Unhampered by Man. F. C. Gates, K. S. C.
5. Distribution of seeds by the Dust Storms. H. Everett Runyon, F. H. K. S. C.
6. A Study of the Flora in Relation to Dust and Drought. A. W. Barton, Professor of Botany, F. H. K. S. C.
7. New Methods of Vitamin A Determination Applied to a Sample of Commercial Butter. Bernice L. Kunerth and Sister Ethelburg Leuschen, F. H. K. S. C.
8. Taste Differences in a Family. S. L. Loewen, Sterling College.
9. Kansas Meteorites Since 1925. H. H. Nininger, Society for Research on Meteorites, Denver.

11:00 a. m. Sound Film: The Human Adventure. Granada Theater.

BOTANY PAPERS

Friday, April 3, 1:30 to 5:30 p. m., Science Hall, Room 108
Chairman: PROF. L. E. MELCHERS

1. Ecological Anatomy of *Chenopodium album,* M. W. Mayberry, U. of K.
2. Ecological Anatomy of *Amphiachyris dracunculoides,* Helen Evelyn Allen, U. of K.
3. Ecological Anatomy of *Sideranthus grindelioides,* Florence Biscoe, U. of K.
4. Ecological Anatomy of *Helenium tenuifolium,* Raymond W. Kuszmaul, U. of K.
5. Observations on the Canker Disease of Gardenias, D. J. Obee, U. of K.
6. Observations on the Morphology and Behavior in Culture of Certain Species of Taphrina. A. J. Mix, and Enda Old, U. of K.
7. Objectives in Small Grain and Sorghum Breeding in Kansas. John H. Parker, K. S. C.
8. Kansas Mycological Notes, 1935, C. L. Lefebvre and C. O. Johnston, K. S. C.
9. Kansas Botanical Notes, 1935, F. C. Gates, K. S. C.
10. Botanical Notes for 1935, Frank U. G. Agrelius, K. S. T. C.
11. Additions to the List of Known Kansas Algae. Rufus H. Thompson, U. of K.
12. Association of Nostocaceae and Characeae in an Aquarium. Clinton C. McDonald, Univ. of Wichita.
13. Notable Trees of Kansas II, Frank U. G. Agrelius, K. S. T. C., and Helen I. Schaefer, formerly K. S. T. C.
14. An Atypical or Staghorn Branch on the Wild Sumac (Rhus glabra). E. O. Deere, Bethany College, Lindsborg.

ZOOLOGY PAPERS

Friday, April 3, 1:30 to 5:30 p. m., Science Hall, Room 5
Chairman: Prof. J. E. Ackert

1. Some Factors in the Morphogenesis of Embryonic Epithelia. F. C. Sauer, Univ. of Wichita.
2. Elimination of Fat for Potash Clearing. Ralph Bogart, and Sam Long, K. S. C.
3. Heterophile Antigen in Some of the Common Helminths. John A. Trimmell and J. Ralph Wells, K. S. T. C., Pittsburg.
4. Effect of Concentration on Toxin Action of Phenol on Simocephalus. John Breukelman, K. S. T. C., Emporia.
5. The Cytoplasmic Components of the Male Germ Cells of the Acrididae. Vernon S. Gentry, U. of K.
6. Spermatogenesis of *Orchelium nigripis,* Myra Wildish, U. of K.
7. Spermatogenesis of *Anasa tristis* (De Geer). Ward Witherspoon, U. of K.
8. Studies on the Comparative Resistance of Two Strains of White Leghorn Chickens to Parasitism. J. E. Ackert, I. Pratt and A. E. Freeman, K. S. C.
9. Stomach Worms of the Cat. J. E. Ackert.
10. The Cysticercoid of the Chicken Tapeworm *Raillietina cesticillus,* J. E. Ackert, and W. M. Reid, K. S. C.
11. Effect of X rays on Tetrad Formation During Cell Division in the Snowy Tree Cricket (*Oecanthus nigricornis argentinus*). Edith Penfield Beach, U. of K.
12. A Study of the Growth Stages of Male Germ Cells in Grasshoppers, Franklin Murphy and W. J. Baumgartner, U. of K.
13. Preliminary Report of a Survey of *Trichinella spiralis* Infections of Rats, Cats and Swine in the Region of Pittsburg. William Roberts and J. Ralph Wells, K. S. T. C., Pittsburg.
14. A Study of the Blood Picture of Rabbits Subjected to Various Types of Smokes. Parley Dennis and J. Ralph Wells, K. S. T. C., Pittsburg.
15. Notes and Comments on Certain American and Mexican Snakes of the Genus *Tantilla* with Descriptions of New Species. Edward H. Taylor, U. of K.
16. Observations on Certain Mexican Amphibians with Descriptions of New Species. Edward H. Taylor, U. of K.
17. Some Effects of Antuitrin-G on Female White Rats Fed a Vitamin-A-free Diet. E. J. Wimmer and John Ayers, K. S. C.
18. A Double Monster Pig—*Thoracapagus monosymmetros.* B. J. Everham and W. J. Baumgartner, U. of K.

Papers Presented by Title

19. A Study of the Myology and Oesteology of Three Sciurids with Regard to Adaptation to Arboreal, Glissant and Fossorial Habits. Harry E. Peterka, Okmulgee, Okla.
20. A New Species of Trematode from the Common "Channel" Catfish. Bertram Caruthers, Lane College, Jackson, Tennessee.
21. Types of American Bombyliidae (Diptera). Reginald H. Painter, K. S. C.
22. Eye Muscle Imbalance Among College Students. Edward L. Askren, K. S. C.
23. A Theory of Education Based on the Heredity and Living Needs of Young People. Lyman C. Wooster, Emporia.

ZOOLOGY PAPERS (Continued)

Saturday, April 4, 10 to 12 a. m., Science Hall, Room 5
Chairman: Dr. J. E. Ackert

1. Notes on Faunal Collecting in Kansas. William Luther Hoyle, K. S. C.
2. The Ecology of a Fresh-water Pool. Tom Groody, K. S. C.
3. The Contents of Owl Pellets as Indicators of Habitat Preferences of Small Mammals. L. D. Wooster, F. H. K. S. C.
4. Effects of Radiation on Annelid Regeneration. R. G. Stone, Univ. of Kansas City, Mo.
5. Additional Notes on the Effect of Drought on Animal Populations in Western Kansas. L. D. Wooster, F. H. K. S. C.
6. Fifth Annual Summary of the Population of the More Important Insects in Kansas Covering the Year 1935. Roger C. Smith and E. G. Kelly, K. S. C.
7. An Annotated List of the Birds of Rooks County and Vicinity. Ralph H. Imler, Stockton.
8. Length of Life for Animals: First, With Food, but Without Water; second, With Water, but Without Food. J. Willard Hershey, McPherson College.
9. Do the Rare Gases Have Any Effect Upon Animal Life, and If So, What? J. Willard Hershey.

CHEMISTRY PAPERS

Friday, April 3, 1:30 to 3 p.m., Science Hall, Room 102
Chairman: C. H. WHITNAH

1. Addition Agents in Acid Copper Plating Baths. Guita Marble and Robert Taft, U. of K.
2. A Study of Plumbic Acetate in Anhydrous Acetic Acid. W. Clarence Lanning and Arthur W. Davidson, U. of K.
3. The Lime Content of the Rocks of the Upper Cretaceous System of Ellis County, Kansas. Lawrence Rarick, Iowa City, Iowa, and Roy Rankin, Hays, Kansas.
4. The Effect of Inorganic Salt Addition Upon the Conductivity of Glyptal Resins. L. E. Blackman, K. S. T. C., Emporia.
5. Nutritional Factors Influencing Vision. Edward L. Askren, Jr., K. S. C.
6. Some Limitations in the Chemical Determination of Vitamin C in Milk. C. H. Whitnah, K. S. C.

PHYSICS PAPERS

Friday, April 3, 3 to 5 p.m., Science Hall, Room 104
Chairman: H. A. ZINSZER

1. A Modification of the Pfund Refractometer. Preston L. Taulbee and Louis R. Weber, Friends Univ.
2. Electrons Moved by Interference Between Their Waves. Eric R. Lyon, K. S. C.
3. Simple Wave Equation Showing Nuclear Boundary. Eric R. Lyon.
4. A Mechanical Model of a Vacuum Tube Amplifier. Louis R. Weber, Friends Univ.
5. Measurements of the Electronic Charge (e) and of the Ratio e/m by College Students. R. F. Miller, College of Emporia.
6. Conduction of Electricity through Vapors. Wm. H. Matthews, K. S. T. C., Pittsburg.
7. A Simple Combined Phase and Azimuth Bi-field. C. V. Kent, U. of K.
8. A Simple Lecture Experiment to Illustrate Magnetic Hysteresis. H. D. Ayers and K. V. Manning, Univ. of Wichita.

PSYCHOLOGY PAPERS

Friday, April 3, 1:30 to 5:30 p.m., Administration Building, Room 208
Chairman: DR. BERT A. NASH, Director Educational Clinic, President, Kansas Psychological Association

1. The Schrammel-Brannan Revision of the Army Alpha Intelligence Examination. H. E. Schrammel, K. S. T. C., Emporia.
2. A Preliminary Study of the Relative Efficiency of Maturation vs. Repetition in the Memorization of Music. Robert L. Brigdon, Wichita Child Research Laboratory.
3. The Correlation Between Writing Age and Maturation. Dorrice Snyder, Wichita Child Research Laboratory.
4. The Problem of Correcting a Class Distribution of Grades in any given College Class. Floyd B. Lee, F. H. K. S. C.
5. The Course Offerings and Curricular Requirements of Psychology in Schools of Technology. O. W. Alm, K. S. C.
6. A Remedial Program for Probationary Freshmen—Some Case Studies. Nicholas D. Rizzo and John P. Puffinbarger, U. of K.
7. A Study of the Relationship between High School Marks and College Success as Measured by College Marks and Entrance Examinations. Vera Davis, K. S. T. C., Emporia.
8. Experimental Training of a Birth-injured Child. Edwina A. Cowan, Wichita Child Research Laboratory.
9. An Exploratory Study of Color Response. Brooks C. Rickard, F. H. K. S. C.
10. A Preliminary Study of Personality Types Through Autokinetic Movement Phenomena. Albert C. Voth, U. of K.
11. The Rorschach Ink-blot Test. Walter A. Varvel, U. of K.
12. The Variable of Amount of Interpolated Activity in Retroactive Inhibition. Joseph W. Nagge, K. S. T. C., Emporia.
13. A More Extensive Study of the Chemo-self-instructional Method in Correspondence Work. B. H. Fleenor, K. S. C. (Presented by Title).

PSYCHOLOGY PAPERS (CONTINUED)

Saturday, April 4, 10 to 12 noon, Science Hall, Room 102
Chairman: MISS BEULAH MORRISON, Prof. of Psychology, University of Kansas

1. Standardizing Tests For Children with Acuity Disabilities. Edra Weathers, Wichita Child Research Laboratory.
2. A Preliminary Study of the Home Maladjustment of Delinquents. Evelyn Lammers, Wichita Child Research Laboratory.

3. An Unemphasized Factor in Current Theories Regarding Transfer of Training. E. E. Bayles, U. of K.
4. Differences Between Schools in Educational Achievement in Relation to Intelligence and Other Factors. Dr. H. B. Reed, Prof. of Psychology, F. H. K. S. C.
5. First Grade Children's Methods of Solving Arithmetic Problems. Ned M. Russell, U. of K.
6. A Comparative Study of Character and Conduct Among Boy Scouts and Nonscouts. Paul Hawkins, Junior H. S., El Dorado.

Election of officers for the Psychological Association, and other business.

JUNIOR ACADEMY PROGRAM

Friday, April 4, 1:30 p. m., Roosevelt High School Assembly Room
Dr. Hazel L. Branch, University of Wichita, in Charge

Presiding Officers: President, Edwin C. Price, Lawrence Nature Study Club, Lawrence; secretary, Virginia Griffin, The Retorts, Shawnee Mission Rural High School, Merriam.

1. Presentation to illustrate, "One Hundred Million Guinea Pigs," The Chemistry Club, Wichita High School East, Wichita. Virginia Russell, Reginald Knowleton, Richard Myers, and Charles M. Dickey.
2. Demonstrations, Ben Franklin Club, Liberty Memorial High School, Lawrence.
   Demonstration of the Stroboscope, by the Physics group, Liberty Memorial H. S., Lawrence, Bob Bullock, student; C. B. Cunningham, instructor.
   Spontaneous Combustion,—(a) Lead Tartrate, (b) Yellow Phosphorus; Needle and Penny; Eating a Lighted Candle: Chemistry Group, Liberty Memorial H. S., Mary Alice Gorrill, Barbara Edmons, students; Robert E. Wood, instructor.
3. Short-wave Radio. The Science Club, Manhattan Senior High School, Manhattan. Louis Raburn, Wallace Rankin, and Ralph Samuelson.
4. Singing Hydrogen. The Retorts, Shawnee Mission High School. Joe Clark.

Induction of new clubs, W. J. Baumgartner, President of the Kansas Academy of Science.
Business Meeting, Edwin C. Price, President of the Junior Academy.
Election of Officers, Sponsored by Chairman of the Junior Academy.
Adjournment.

GENERAL PAPERS AND BUSINESS

Saturday, April 4, 8:15 a. m. to 12 noon, Science Hall, Room 5

1. Botanical Observations Roundabout the Dust Bowl. W. C. Stevens, U. of K.
2. A Preliminary Report of Some Evolutionary Cycles. Raymond Holder Wheeler, U. of K.
3. Fat as a Factor in Palatability of Beef. David L. Mackintosh and J. Lowe Hall, K. S. C.
4. Illustrated Report of the Committee on Natural Areas and Ecology. Walter H. Schoewe, U. of K.
5. Reclamation Program in Southeast Kansas. Wm. H. Matthews, Pittsburg.

Academy Business Session

9 to 10 a. m.

6. Miscellaneous Notes on Kansas Amphibia and Reptiles. John Breukelman, and Allen Downs, K. S. T. C., Emporia.
7. Fluctuations in the Insect Populations of Pastures at Manhattan, Kansas, During the Drought Years 1933-1935. D. A. Wilbur, K. S. C.
8. Some Mammals of a Nebraska Prairie. Don B. Whelan, U. of Nebraska.
9. Amphibia and Reptiles of Chase and Lyon Counties. John Breukelman, and Allen Downs, K. S. T. C., Emporia.
10. The Amphibians and Reptiles of Mammoth Cave National Park, as Proposed. Claude W. Hibbard, U. of K.
11. Differential Resistance of Strains of Wheat to Chinch Bug Attack. E. T. Jones, U. S. Bur. of Ent. and Plant Quar.

ENTOMOLOGY PAPERS

Saturday, April 4, 10 a. m. and 1:30 p. m., Science Hall, Room 104

(Kansas Entomological Society, 12th annual meeting: Kathleen Doering, Lawrence, President; D. A. Wilbur, Manhattan, vice-president; R. L. Parker, Manhattan, secretary-treasurer. Business meeting 10—11 a. m. Presentation of papers, 11:30—12, and at 1:30.)

1. Dissection Technique for Studying Male Genitalia of Leafhoppers. Melvin E. Griffith, U. of K.
2. Notes on the Classification of Three Genera of Delphacidae (Homoptera). Lawrence Penner, U. of K.
3. Some Observations on the Coleoptera of the Prairie. Don B. Whelan, U. of Nebraska.
4. Recent Additions of Curculionidae (Coleoptera) to the Snow Entomological Collection. Lyman Henderson, U. of K.

5. "Beetles Have Eight Legs." Milton Sanderson, U. of K.
6. Life History of the Spotted-sided Cutworm *Agrotis badinodis* Grote (Lepidoptera, Noctuidae). H. H. Walkden, U. S. Bur. Ent. and Plant Quar., Manhattan.
7. The Head Musculature of the Carolina Mantis, *Stagomantis carolina* L. (Orthoptera, Mantidae). Philip Leverault, U. of K.
8. Notes on Flour Mill Insects. N. E. Good, U. S. Bur. of Ent. and Plant Quar., Manhattan.
9. A Curious New Anisops (Hemiptera, Notonectidae) from Timor Island. H. B. Hungerford, U. of K.
10. Hessian Fly Eggs and Freezing Temperatures. W. T. Emery, U. S. Bureau of Entomology and Plant Quarantine.
11. Negative Prints as an Aid to the Study of Microscopic Structure. R. H. Beamer, U. of K.
12. Cankerworms and Population Trends. E. J. McNay and R. L. Parker, K. S. C.
13. Butterflies of Kansas. William Field, U. of K.
14. Preliminary Report on the Mosquitoes of Kansas. Noblesse DeMoss, K. S. C.
15. We Have Roaches. Thompson Lawrence, U. of K.
16. Soil Insecticides as a Control for Subterranean Insects. Harry R. Bryson, K. S. C.
17. The Shoe-box Rearing Method as a Stimulus to Winter Insect Collecting. D. A. Wilbur, K. S. C.
18. Mound Builders. Theo. H. Scheffer, U. S. Bur. of Biol. Survey, Puyallup, Washington.
19. Studies on Specificity of Insect Tissue. Henry Thomas, U. of K.

Final business meeting and election of officers.

MINUTES OF THE SIXTY-EIGHTH ANNUAL MEETING

The sixty-eighth meeting of the Kansas Academy of Science was held at Emporia, Kan., April 2 to 4, 1936. The opening address was given by Prof. George A. Dean, a graduate of K. S. C., Manhattan, in 1895, on the subject: "The Practical Use of Insects for the Control of Insect Pests and Noxious Weeds." The lecture, which was illustrated with lantern slides, was given in the music hall auditorium.

The first meeting of the general session was called to order by President W. J. Baumgartner at 8:15 Friday, April 3, in Science Hall, and at 11 o'clock the session adjourned to see the sound film, "The Human Adventure," which was a pictorial record of archeological investigations of the University of Chicago, the late Dr. Henry Brestead giving the accompanying lecture. The film was shown at the Granada theater for the students of the college and Academy guests through arrangements by President T. W. Butcher.

The annual banquet, held in the Memorial Union ballroom, was attended by 154 persons. Adjourning to the auditorium, President Butcher, of the college, gave the address of welcome. This was followed by the annual address of the president of the Academy, which was delivered by Dr. W. J. Baumgartner, on the subject, "The Cell in Growth and Reproduction." The lecture, which was illustrated by slides and motion pictures of living cells, included much of the author's own research in the field of cytology. This address was followed by the annual invitation address by the Hon. William Allen White on the subject: "Glimpses of the Orient."

Exhibits by educational supply firms and instrument dealers were a feature of the meeting.

The attendance at the various meetings follows:

Lecture by Prof. Geo. A. Dean	145
General sessions	150 and 135
Banquet	154
Lecture by W. A. White	300
Botany section	75
Chemistry and Physics	75

Zoölogy	60
Psychology	60
Entomology	60
Junior Academy	120

The program was presented as printed, and the business meeting was held Saturday, April 4. At the close of the business session the new president, Prof. Lawrence Oncley, was called to the chair. The reports of the various officers and committees are appended.

Sectional meetings in botany, chemistry, physics, zoölogy, psychology and the junior academy were conducted Friday afternoon, with continued sessions in zoölogy and psychology Saturday morning. The entomology section met Saturday after the Academy business meeting. The program included 112 papers listed to be read and six presented by title. Two deaths during the year in the Academy membership were reported: Dr. A. S. Hitchcock, an honorary member, and A. E. Oman.

The research fund of $75 from the A. A. A. S. will be augmented by $25 from the Academy treasury for allotment during the coming year. This fund will be awarded by a special committee consisting of Dr. L. D. Wooster, Hays; Dr. R. Q. Brewster, Lawrence; and Dr. J. C. Peterson, Manhattan. Dr. W. H. Schoewe reported progress in the committee on natural areas, particularly in regard to the movement to have a small area containing unusual rock formations near Minneapolis, Kan., set aside for a state park.

The appended reports of all committees were read and accepted. The committee on natural areas was continued. The matter of providing each member of the Academy in good standing with a small membership card was presented and approved. The cards are to be distributed at the annual meeting. The executive committee approved for presentation to the Academy a revision of article 7 and a new bylaw regarding the reinstatement of members. A payment of $25 towards defraying the expenses of Dr. Frank C. Gates, editor of the TRANSACTIONS, to the A. A. A. S. meeting at St. Louis, in appreciation for his services to the Academy, was approved. Dues hereafter are to be sent to the treasurer instead of to the secretary.

A few advance copies of volume 38, which is the TRANSACTIONS for 1935, were distributed at the meeting. Especial credit for the success of the meetings was given to Frank Agrelius and J. B. Stroud, of the Teachers College, who constituted the committee on arrangements. The following section chairmen were elected: J. H. Doell, Newton, botany; L. E. Blackman, Emporia, chemistry; Louis R. Weber, Wichita, physics; F. C. Sauer,[1] Wichita, zoölogy; Edwina A. Cowan, Wichita, psychology; Donald A. Wilbur, Manhattan, entomology; and Hazel Branch, Wichita, junior academy. Frank C. Gates continues as editor of the TRANSACTIONS.

A new committee, consisting of O. W. Alm, Manhattan, A. C. Carpenter, Ottawa, and Miss Dale Zeller, Emporia, was appointed to study educational trends in the secondary schools of the state with respect to the basic sciences.

The next meeting of the Academy will be held at Kansas State College, Manhattan, during the spring of 1937.

ROGER C. SMITH, *Secretary.*

April 6, 1936. W. J. BAUMGARTNER, *President.*

1. Since deceased.

REPORT OF THE SECRETARY, 1935-'36

At the close of the meeting at Lawrence, on March 30, 1935, President Baumgartner appointed the committees. A letter expressing the appreciation of the Academy for printing volume 37 was written to W. C. Austin, state printer, and a letter transmitting the resolution of the Academy concerning the death of Dr. George E. Johnson was sent to Mrs. Johnson.

The executive council met with the committees on conservation of natural areas and of publication at Lawrence, April 19, 1935. The report of this meeting is appended.

The secretary notified members delinquent in their 1935 dues on April 24, and the response was excellent.

The secretary moved the back volumes of the TRANSACTIONS belonging to the Academy from Fairchild Hall to the college library. The fire hazard and possible damage from dust and moisture are very materially reduced. The volumes were counted and a new price schedule for the numbers worked out as printed in volume 38.

The president and secretary were notified on August 3, 1935, that the American Association for the Advancement of Science would offer the Kansas Academy of Science $75 to be awarded for research among its membership. The officers, acting for the Academy, accepted the proposal, and President Baumgartner ruled that the executive committee should have charge of making the awards. Applications for this award were solicited from the membership by a mimeographed circular letter sent out in September. Only four applications were received for the award or any part of it. Three of these were at the time residing outside the state. The executive committee investigated all applications thoroughly and finally unanimously agreed to award half of the amount, or $37.50, to Dr. J. W. Hershey, of McPherson College, and an equal amount to Richard Zinszer, a graduate student in physics, at the University of Indiana. These awards were made in early November and checks were immediately sent to the two recipients from the American Association headquarters at Washington.

Those delinquent in dues were again notified October 18, but the response was slight.

Dr. F. C. Gates, editor of the TRANSACTIONS, and the secretary represented the Academy at the annual academy conference December 30, 1935, with the latter as the voting representative. Considerable emphasis was given the Junior Academy at the conference. It is expected that the $75 research fund will be available again this fall for awarding among our membership. It is suggested that the Kansas Academy attempt to increase this fund from private donations or from the Academy treasury as a few other academies have done.

Notices of the Emporia meeting, the notices of dues for 1936 and the call for titles were mailed February 1. The response was again gratifying. A full program of titles except in the sections on chemistry and physics was arranged for printing on March 10. Twelve hundred copies of the program were ordered and about half of them distributed before the Emporia meeting.

The printed TRANSACTIONS for 1935 were not received from the state printer up to April 1, 1936. Envelopes preparatory to the distribution of this volume to the membership were addressed a month or more earlier. Cards with a return portion upon which the forthcoming volume might be requested were sent to honorary and life members, and to members of the legislature. About two thirds of the legislators requested volumes, about five sixths of the life members did so, but less than half of the honorary members requested the 1935 volume.

A five-drawer letter file with one drawer provided with a lock for a stamp drawer, and a rebuilt Royal typewriter were bought for the secretary's office during the year. Exceptionally good prices were obtained in both cases.

During the coming year the matter of trading in the old, out-of-date addressing machine for more modern equipment should be considered. A steel cabinet in which Academy property may be kept under lock and key is recommended. It is seriously needed.

STATUS OF MEMBERSHIP OF THE ACADEMY

Membership on April 1 is as follows:

Annual members reported in 1935 Transactions*	381	
Life members reported in 1935 Transactions	50	
Honorary members reported in 1935 Transactions	11	
Total membership, 1935		392
Former members reinstated	5	
New members, April 1 to January 1, 1936	10	
New members, January 1 to April 1, 1936	50	
Total new members		65
Members dropped, nonpayment of dues	19	
Resigned	2	
Deceased	6	
Total loss since April 1, 1935		27
Net increase in membership since April 1, 1935		38
Grand total, members all classes, April 1, 1935		430

The following members died during the year: A. S. Hitchcock and A. E. Oman. In volume 38, Dr. J. M. McWharf, a life member, was erroneously reported as deceased, due to confusion of names. A letter of apology and explanation was written to Doctor McWharf.

REPORT OF THE MEETING OF THE EXECUTIVE COUNCIL

WITH THE COMMITTEES ON CONSERVATION OF NATURAL AREAS AND PUBLICATION

Meeting held April 19, 1935, at Lawrence, Kan.

The following officers were present: Messrs. Baumgartner, Oncley, Hall, Smith, Zinszer, Gates, Schoewe, Martin, Matthews, Taft, Kelly, Deere, Floyd, Burt and Horr.

The council recommended that members of the legislature who wish copies of the TRANSACTIONS be informed by card (with return portion) that they can get them.

Recommended that life members be given the same privilege and that no copies be sent to them unless the reply is received, the assumption being they are no longer interested if the card is not returned.

Doctor Gates reported that the prospects for the 1935 volume of the TRANSACTIONS indicated a volume the same size as No. 37, 1934. He pointed out there was need for general directions to authors. Only papers presented at the meetings will be included in the TRANSACTIONS. He pointed out the need for strong papers, and especially papers dealing with Kansas materials. He advised printing on the program that only members whose dues for the year and bills for reprints of previous volumes are paid, will be permitted printed papers in the TRANSACTIONS.

Moved by Gates that the Academy not accept papers from members for printing unless they are paid up to date on membership dues and reprint bills. Motion carried.

Moved by Baumgartner that a statement be made, when calling for papers, that there is no charge for printing of papers except to cover the office costs of stamping and handling reprints. The motion carried.

During the discussion it was agreed that the editor will determine the

* 283 annual members were reported (p. 24) with dues paid, but a full count of the names listed gives 341. However, the names of 10 new members were inserted, making 381 annual members.

proper number of plates acceptable with papers. Amended by Taft that abstracts of the papers be grouped at the end of each volume of the TRANSACTIONS. The motion was passed as amended.

It was suggested that plates and illustrations may be printed on a finer grade of paper than is used in the TRANSACTIONS when paid for by authors, and inserted in the volume without extra cost for the insertion, if the regular paper will not give the desired results.

Doctor Oncley reported to the executive council the following proposed lines of work for the Committee on Natural Areas:

1. To contact garden clubs, chambers of commerce, clubs and similar organizations with reference to the work of this committee.
2. To authorize Doctor Schoewe, the chairman, to serve as contact man in reaching the proper agencies.
3. To take steps to have the natural area near Minneapolis, Kan., set aside for a state park.
4. To ask the executive committee for a sum of not over $50 for expenses in carrying out this program.
5. To ask for a report from the State Fish and Game Commission as to the location and extent of present state parks.
6. To offer the services of the committee to the state fish and game commissioner.
7. To have members of the Academy write articles for local newspapers emphasizing the importance of preserving the natural areas in the state for posterity.
8. To encourage and give assistance towards labeling trees in public parks with their common and scientific names—this assistance for the time being to be limited to technical assistance and not to buy labels.

This program was approved by the executive council.

Moved by the secretary that the committee be allowed up to $50 from the treasury of the Academy for expenses in carrying out the proposed program. Motion carried.

Moved by Zinszer that the Committee on Natural Areas be increased by adding a member from western Kansas. The motion passed, and Doctor Baumgartner appointed L. D. Wooster to serve on this committee.

It was urged that a paper be written on the natural areas in the state and present state parks for the TRANSACTIONS and that a large number of reprints be obtained for distribution.

With respect to Doctor Baumgartner's suggestion for a Kansas Association for Advancement of Science, it was decided that the matter be taken under advisement and that for the time being the executive committee of the Academy functions where the Academy needs such representation.

It was stated that sending out printed cards for new members is better than sending mimeographed blanks. It was advised that several be sent to each member of the membership committee and one with each notice to members.

With reference to $600 of Academy funds in postal savings, it was decided that this sum be transferred to the endowment fund, but left in postal savings for the time being.

It was pointed out that mimeographed directions upon the duties of officers and committees prepared by past holders of these appointments would be a great aid to new incumbents. It was decided to ask last year's officers, members of last year's local committees of arrangements and chairmen of sections to prepare brief accounts of the duties and suggestions for carrying on the

work of their respective offices most successfully, that these be mimeographed and distributed well before the Emporia meeting.

It was decided that the secretary provide section chairmen with postage and correspondence materials upon request.

The meeting adjourned.

ROGER C. SMITH, *Secretary.*
W. J. BAUMGARTNER, *President.*

NEW MEMBERS

From March, 1935, to April 4, 1936

Name	*Section, Subject*	*Recommended by—*
Allegre, Charles	Botany	John Breukelman
Allen, Evelyn Helen	Botany	W. C. Sterns
Askren, Edward L., Jr.	Physio. Optics	Roger C. Smith
Albertson, F. W.	Botany	Roy Rankin
Angell, Wenonah E.	Biology	Frank Agrelius
Ayers, John C.	Zoölogy	Roger C. Smith
Bartholic, Robert L.	Physics, Zoölogy	H. A. Zinszer
Bogart, Ralph	Zoölogy	Roger C. Smith
Beck, James Theodore	Zoölogy	B. Caruthers
Bryan, Aldro	Chemistry	L. E. Blackman
Borman, Ina A.	....	....
Chappell, Wilburt	....	Roy Rankin
Caruthers, Bertram	Biology	W. J. Baumgartner
DeMoss, Noblesse	Entomology	Roger C. Smith
Downs, Allen	Zoölogy	John Breukelman
Davis, Vera	Psychology	H. E. Schrammell
Everham, Barbara	Zoölogy	W. J. Baumgartner
Farber, Louis M.	....	F. C. Gates
Fleenor, B. H.	Education	Roger C. Smith
Freeman, Alva E., Jr.	Zoölogy	Roger C. Smith
Fry, Kenneth A.	Zoölogy	H. H. Hall
Gladfelter, C. D.	Biology	Frank Agrelius
Gorham, Maude I.	Psychology	Roy Rankin
Griswold, Sylvia M.	Biology	W. J. Baumgartner
Groody, Thomas C.	Zoölogy	Roger C. Smith
Hanson, Hugh	Biology	Frank Agrelius
Hughbank, Rev. Leroy	Physics	R. K. Nabours
Hunsicker, Franklin	Chemistry	L. E. Blackman
Imler, Ralph H.	Zoölogy	W. J. Baumgartner
Jones, Mary Alice	Entomology	Renewal
Kerr, W. H.	Psychology	Roger C. Smith
Kirkpatrick, E. L.	Biology, Physics	Renewal
Kroeker, E. H.	Chemistry	J. H. Doell
Kussmaul, Raymond W.	Botany	W. C. Stevens
Lanning, W. Clarence	Chemistry	Arthur W. Davidson
Leuschen, Sr. Ethelburg	Nutrition, Chemistry	Martha M. Kramer
Mackintosh, David L.	Meat	Roger C. Smith

Name	*Section, Subject*	*Recommended by—*
Murphy, Franklin	Zoölogy	W. J. Baumgartner
Overholt, Ward H	Physics, Gen. Science	F. U. G. Agrelius
Rarick, Lawrence	Chemistry	Roy Rankin
Reed, Homer B.	Psychology	H. A. Zinsser
Reid, W. Malcom	Zoölogy	J. E. Ackert
Rickard, Brooks C.	Psychology	H. B. Reed
Russell, Ned M.	Psychology	R. H. Wheeler
Runyon, H. Everett	Chemistry	Roy Rankin
Smedley, Melbern	Chemistry	Roy Rankin
Stone, R. G.	Zoölogy	J. E. Ackert
Tihen, Joe A.	Zoölogy	Claude W. Hibbard
Trimmell, John A.	Biology	Roger C. Smith
Turner, Clair K.	Health	John Breukelman
Warnock, W. G.	Mathematics	Roy Rankin
Welch, Bernard H	Zoölogy	W. J. Baumgartner
Wetmore, Alexander	Ornithology	Chas. E. Burt
Wheeler, R. H.	Psychology	Renewal
Whitnah, Carroll H	Chemistry	Roger C. Smith
Wildish, Myra	Zoölogy	W. J. Baumgartner
Witherspoon, Ward	Zoölogy	W. J. Baumgartner
Wolfson, Charles	Zoölogy	W. J. Baumgartner
Zoe, Sr. Mary	Chemistry	L. E. Blackman

Junior Academy Groups

Science Classes, Roosevelt High School, Emporia	Hazel Branch

Resigned.—H. W. Putnam, Hays; D. C. Warren, K. S. C., Manhattan.
Totals: Renewals, 4; new members, 60; resigned, 2. Net increase, 62.

REPORT OF TREASURER

March 29, 1935, to April 2, 1936

Receipts

Balance on hand, April 5, 1935	$114.13
Dues from members	279.00
Sale of reprints to members	38.50
Sale of back volumes of Transactions	7.60
Kansas State College, vol. 37	200.00
University of Kansas, vol. 38	200.00
Fort Hays Kansas State College, vol. 38	100.00
Interest on endowment fund	30.39
Principal and interest on postal certificates	503.30
1935 appropriation by Kansas legislature	300.00
Total	$1,772.92

Disbursements

Kimball Printing Co.: Printing	$35.00
Manhattan Floral Co.: Wreath	2.50
Editor: Trip to Lawrence	6.90
Ecological Society of America: Donation	5.00
Postal savings certificates, G471997 and 8	200.00
W. J. Baumgartner: Expense securing state aid	18.50
Secretary's office:	
Mimeographing; addressing; stenographic work	54.84
Postage (in part for other offices)	36.31
Supplies	21.48
Filing cabinet	27.50
Rebuilt typewriter, less trade-in	35.00
W. C. Stevens: Dues refund	1.00

H. H. Hall: Council meeting	$4.50
U. S. Savings Bond C418789 ($100)	75.00
U. S. Savings Bond D74388 ($500)	375.00
U. S. Savings Bond C446461 ($100)	75.00
U. S. Savings Bond C446462 ($100)	75.00
Geo. A. Kelly: Council meeting	5.00
Hazel Branch: Junior Academy Supplies	6.32
Treasurer: Rubber stamp	.52
Capper Engraving Co.: Cuts for vol. 38	218.19
Postal savings certificates H171241 and 2	400.00
Balance on checking account	49.36
Total	$1,772.92

Supplementary Statement on Financial Condition of Academy

Bank balance	$62.79	
Three $100 postal savings certificates	300.00	
Two $200 postal savings certificates	400.00	
Due from Kansas State College (Manhattan)	200.00	
Total		$962.79
Uncanceled checks	$13.43	
Payable to endowment fund	32.90	
Total		46.33
Net balance		$916.46

Respectfully submitted,
Harvey A. Zinszer, *Treasurer*.

REPORT OF ENDOWMENT COMMITTEE

Receipts

Balance in general fund	$2.51
Earnings during 1935	30.39
Transferred from general fund	600.00
Total	$632.90

Disbursements

U. S. Savings Bond C418739 ($100)	$75.00
U. S. Savings Bond D74388 ($500)	375.00
U. S. Savings Bond C446461 ($100)	75.00
U. S. Savings Bond C446462 ($100)	75.00
In general fund	32.90
Total	$632.90

Investments

4 Shares (AC99-102) Morris Plan, Wichita 6%	$400.00
5 Shares (OS-1181) First Federal Savings and Loan Ass'n of K. C. $94.53; Western Shares, Inc. $205.47	300.00
3 Shares (No. 7859) Greene Co. B. & L., Springfield	300.00
1 (11359-K) U. S. Treasury Bond, 1951-55 @ 3%	100.00
1 (670-L) U. S. Treasury Bond, 1951-55 @ 3%	50.00
1 (L-394870) $50 U. S. Treasury Savings Bond, 1945	37.50
1 (C-446473) $100 U. S. Treasury Savings Bond, 1945	75.00
*1 (D84554) $500 U. S. Treasury Savings Bond, 1945	375.00
*2 (C446471-2) $100 U. S. Treasury Savings Bonds, 1945	150.00
In general fund	32.90
Total	$1,820.40

This year the Western Savings and Loan, Kansas City, was reorganized and new certificates given out under the names of First Federal Savings and Loan Association, and the Western Shares, Inc., as apportioned above. The latter organization represents the questionable assets of the old company. The Greene Co. B. & L. not only passed both semiannual dividends but went into the receiver's hands temporarily. A movement is on foot to reorganize this company along the lines of the old Western Savings and Loan.

Zinszer, Grimes, Smith and Brewster.

* D84554 was originally D74388, while C446471-2 were originally C446461-2. The post office exchanged these bonds because they were incorrectly issued.

REPORT OF AUDITING COMMITTEE

The committee has made an audit on the books of the treasurer, Mr. H. A. Zinszer, and finds the books as per his report.

The committee would like to recommend that the treasurer be bonded for the sum of $1,000, expense of the bond to be carried by the Academy.

(Signed) O. P. Dellinger,
George A. Dean,
Auditing Committee.

REPORT OF THE DELEGATES TO THE ACADEMY CONFERENCE

The Academy Conference at St. Louis, December 30, 1935, was attended by R. C. Smith as official delegate and F. C. Gates as alternate. The group of about 60 discussed two topics at length. Requests for definite rules and regulations for the awarding of the American Association prize money were turned back to the academies with the statement that each academy was responsible for setting up its own rules and regulations for the selection of the recipient of the prize money.

Considerable discussion of ways and means of furthering the Junior Academies brought out the following: In order to help with junior programs, *Science News Letter* is offering to use 2 to 4 pages eight times during the year for program suggestions, source material, and items of news. The copy for these pages would be supplied in part by the academies. A low price will be set on these numbers to have them reach as many Junior Academy members as possible. Another suggestion was that the Junior Academies might well take a page in their high-school annuals. The feeling is that furthering the Junior Academy work was one of the most important things that the Academy Conference can possibly do.

R. C. Smith, *Delegate.*
F. C. Gates, *Alternate.*

REPORT OF THE EDITORIAL BOARD

The usual editorial work on volume 38 was done. The editorial board took up the matter of writing a manual for authors in the Transactions. The suggestions of the various members of the board, the secretary, the state printer's office, and an engraver have been combined to make a manual which we believe will greatly simplify the work of editing each volume. It is proposed that this be included in volume 39 of the Transactions.

F. C. Gates, *Editor.*

REPORT OF THE COMMITTEE ON NATURAL AREAS AND ECOLOGY

The Committee on Natural Areas and Ecology met in Lawrence on April 19, 1935, for the purpose of planning and discussing its work for the year. The following projects were approved and definite assignments were made.

Project 1. A general survey of state and county parks for the purpose of ascertaining what areas in Kansas are now established. The survey also to include a study of state parks in several selected states for purposes of comparison.

This survey is under way and reports have been received from several of the states. The project is not completed.

PROJECT 2. A project to educate the public in the matter of recognizing and identifying the common trees and shrubs of Kansas by properly labeling them at places where the public commonly congregates, such as our city parks, school grounds, courthouse lawns, college campuses. The work of the committee consists in interesting civic and service clubs, garden clubs, etc., to carry out the project, the committee aiding only in offering its service in a purely advisory capacity.

Progress has been made. The chairman of the committee addressed a gathering of flower clubs representing the Associated Garden Clubs of Northeastern Kansas last October at Lawrence. Considerable interest was aroused and favorable discussion followed. We have assurance of coöperation from this group. At Lawrence, the K. U. Botany Club is now busily engaged in preparing labels for trees and shrubs to be placed on the University campus. At Pittsburg and vicinity approximately 100 trees and shrubs have been labeled, some of these being on the Pittsburg Teachers College campus. The project was financed by the civic and service clubs of Pittsburg.

PROJECT 3. To acquaint the people of Kansas, as well as others, of our natural areas, native plant and animal life, and to direct attention to the importance of preserving certain areas for posterity, as well as advocating the conservation of our native animal and plant life. To do this: (1) Popular articles are to be written for the newspapers and magazines; (2) radio talks are to be broadcast; (3) popular addresses are to be given before scientific groups, high schools, civic and service clubs, etc., and (4) any other methods by which the public might be reached.

Considerable progress has been made. A number of radio talks were given by members of the Kansas University faculty. Professor Horr gave four talks over the radio on trees and shrubs, the geology staff gave seven talks on the geology of Kansas. Other talks were undoubtedly given but not reported to the chairman. The Kansas University radio talks have been mimeographed and sent to those requesting the same. The local newspapers gave considerable space to these talks.

Some of the natural areas of Kansas are well represented by a set of 31 beautifully colored lantern slides and a two-reel movie, prepared under the direction of the Kansas Geological Survey. The slides and movies are available for showing to any organization through the Kansas University Bureau of Visual Instruction. The slides and movies have been shown a large number of times to many people before various organizations in Lawrence and vicinity. The slides have also been sent out over the state for showing to a large number of communities.

A booklet entitled "Scenic Kansas" has been prepared by Dr. K. K. Landes of the Kansas Geological Survey and will be ready for distribution in a short time.

PROJECT 4. To offer the services of the committee to the State Fish and Game Commission. This was done.

PROJECT 5. To establish a national monument near Minneapolis, Kan. At this locality a large number of huge sandstone concretions occur. The area is

of considerable geologic and scenic interest and is also desirable because of its ecological importance. The committee was authorized to make a survey of the area, but due to unavoidable circumstances the survey was not made. It is hoped that such a survey will be made during the Easter recess and a detailed report submitted at the next meeting.

Recommendations:

1. The Academy contribute $5 to the work of the Committee on the Preservation of Natural Conditions for the United States of the Ecological Society of America.
2. Present committee be permitted to continue with the projects outlined and started.

The above report was illustrated by two papers presented on Saturday, April 4, "Illustrated Report of the Committee on Natural Areas and Ecology," Walter H. Schoewe; and paper 5, "Reclamation Program in Southeast Kansas," by Wm. H. Matthews.

C. E. Burt, W. A. Matthews,
H. H. Hall, L. D. Wooster,
W. T. Horr, W. H. Schoewe, *Chairman.*

JUNIOR ACADEMY OF SCIENCE

The Junior Academy of Science held its sixth annual meeting at the Roosevelt High School in Emporia. There were 110 students and 10 adults in attendance. The Roosevelt High School adjourned classes for the first hour of the meeting and after the session the students acted as hosts to the visiting students, entertaining some of them overnight.

The visiting representatives numbered: Wichita East, five; Shawnee Mission, four; Manhattan Senior, seven; Lawrence Junior, five; and Liberty Memorial, Lawrence, four.

The session was presided over by Edwin C. Price, Liberty Memorial, and Virginia Griffin, of Shawnee Mission. The program, as outlined ahead, was given before an appreciative audience. A business meeting followed, at which the following officers were elected: Louis Raburn, of Manhattan, president; Betty Coulson, of Shawnee Mission, secretary.

At the evening session of the Senior Academy, the judges announced the winners of the demonstrations and papers as follows: First in demonstrations—Wichita High School East, Chemistry Club; first in papers—Manhattan Senior High School.

The Roster of the Junior Academy

School and City	*Club*	*Sponser*
Wichita High School, East	Chemistry Club	J. A. Brownlee
Manhattan Senior High School, Manhattan	Science Club	Kenneth Benne
Liberty Memorial High School, Lawrence	Ben Franklin Club:	
	Physics	C. B. Cunningham
	Chemistry	Robert E. Wood
Lawrence Junior High School, Lawrence	Nature Club	Miss Edith Beach
Shawnee Mission Rural High School, Merriam	The Retorts	Jas. C. Hawkins
Roosevelt High School, Emporia	Science Classes	Anna McCullough
Junction City Senior High School, Junction City,	Science Club	H. R. Callahan

For the coming year, the congressional districts are to be used as groups for more intensive work in the Junior Academy. A member of the committee

will be chosen from each of these districts and it will be the privilege of each committeeman to interest the high schools of his district: first in organizing Science Clubs; and second, in affiliating these clubs with the State Academy.

The members of this committee are:

Edith Beach, Lawrence
Kenneth Benne, Manhattan
Dewey Bennett, Garden City
J. A. Brownlee, Wichita
H. R. Callahan, Junction City
L. W. Cooley, Dodge City
Harry Dodd, Great Bend
C. H. Dresher, McPherson
Jas. C. Hawkins, Merriam
Kenneth Huff, Preston
August Lind, La Crosse
Frank Pentup, Beloit
Mary Walker, Hays
Robert Ward, Dodge City
Ralph J. Wells, Pittsburg
Fred Williams, Preston
Robert E. Wood, Lawrence

Respectfully submitted, HAZEL E. BRANCH

NECROLOGY

The committee on necrology presents obituaries of A. S. Hitchcock and of F. C. Sauer.

ROY RANKIN, *Chairman.*
L. E. MELCHERS,
W. B. WILSON, *Committee.*

ALBERT SPEAR HITCHCOCK

(Condensed from the obituary by Mrs. Agnes Chase, Science, 83 :222-224, 1936)

Albert Spear Hitchcock, the eminent agrostologist, died on December 16, 1935, on board the S. S. *City of Norfolk,* homeward bound from Europe with his wife. He had attended the International Botanical Congress at Amsterdam as a delagate and remained in Europe studying the grass collections in several large herbaria. After a heart attack on the 14th the end came quietly, his wife beside him, on the morning of December 16.

He was born on September 4, 1865, at Owasso, Mich., grew up in Nebraska and Kansas, attended Iowa State Agricultural College, where he was a student of Prof. Charles E. Bessey and of Prof. Herbert Osborn, graduating in 1884, the youngest of his class. He was appointed assistant in chemistry for 1885 and took postgraduate courses in chemistry and other sciences and continued work in botany under Prof. B. D. Halstead, Professor Bessey's successor. In the fall of 1886, just twenty-one years old, he was appointed instructor of chemistry at the State University, Iowa City. In 1889 he gave up this position to go to the Missouri Botanical Garden, St. Louis, under Dr. W. Trelease, as instructor in botany in Washington University and curator of the herbarium.

In 1890 began his career as botanical explorer and productive taxonomist. The first trip was one of three months' duration to the West Indies, with Dr. J. T. Rothrock, of the University of Pennsylvania, and two young assistants.

In January, 1892, he was appointed professor of botany and botanist to the experiment station at the Kansas State Agricultural College, Manhattan, Kan., remaining there nine years. Several vacations during these years Professor Hitchcock spent botanizing in Florida.

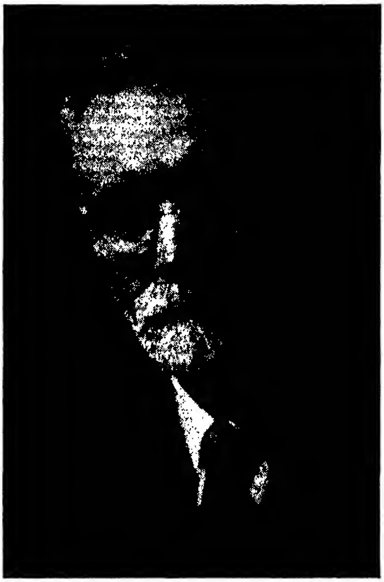
In March, 1901, he went to Washington as assistant chief of the Division of Agrostology, of which Prof. F. Lamson-Scriber was chief, and in 1905 took charge of the Grass Herbarium, which he held to his death.

These were fruitful years of collecting and field study in all parts of the

United States and in many parts of the rest of the world. He collected more than 25,000 numbers, mostly grasses.

During all these years, beginning with *Leptochloa* in 1903, Professor Hitchcock published a succession of scholarly revisions of grass genera, regional grass floras, and also a large number of other papers, his bibliography containing some 250 titles.

His observations on the habits and range of variations of grasses in the field and his wide knowledge of plant geography and special knowledge of grasslands developed a sound taxonomic judgment and the ability to interpret specimens in the herbarium. This led to the "type concept," the idea of basing names upon a type specimen, a scientifically sound idea, the adoption



ALBERT SPEAR HITCHCOCK

of which in the botanical world has largely been due to the efforts of Professor Hitchcock.

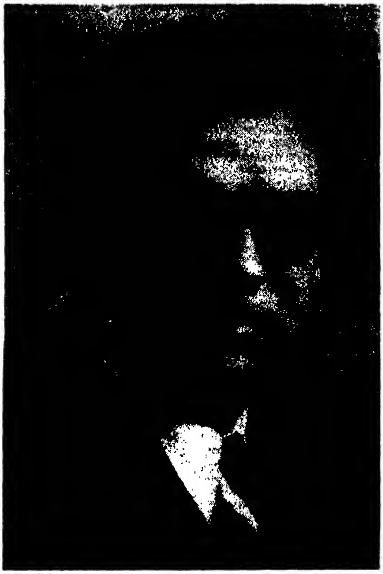
While Professor Hitchcock specialized on grasses for the last thirty-five years his interest in the advance of botany as a whole is shown not only in the work of locating types of grasses, and other plants as well, but also in several notable addresses such as "The Scope and Relations of Taxonomic Botany," and in time-consuming service on various committees. In 1919 he was made a member of the Organization Committee for Biological Research of the National Research Council, and in 1920 chairman of the executive committee of the newly organized Institute for Research in Tropical America, remaining chairman until June, 1926. The idea of preserving a bit of tropical jungle in the Canal Zone originated with him. He pushed the project vigorously, and as a result Barro Colorado Island was made a permanent preserve.

One of Professor Hitchcock's great contributions to science was his helpfulness to colleagues in places remote from large libraries and herbaria, and his encouragement of younger workers. To the succession of students who have studied at the Grass Herbarium, he gave freely of his time and learning,

but he always sought to develop independent judgment in the student. His truly scientific attitude and magnanimity were displayed in his relations with his colleagues and especially with the staff of the Grass Herbarium.

The publication of the Manual of Grasses of the United States and the fact that the first printing was sold out and a second ordered before the work had been out two months was a great satisfaction to him. Before leaving for Amsterdam in August last he finished the manuscript of a Manual of Grasses of the West Indies.

On March 16, 1890, he married Rania Belle Dailey, of Ames, Iowa. To them five children were born.



FRED CHARLES SAUER

A characterization of the man could hardly be better worded than it was by Dr. Willis Lynn Jepson in the copy of his "Flora of California," presented to Professor Hitchcock in 1925: "Eager explorer, far-seeing botanist, and wise promoter of scientific research in America."

Fred Charles Sauer (1903-1936)

Dr. Fred Charles Sauer, assistant professor of zoölogy at the University of Wichita, died April 16, 1936, from streptococcus septicemia. He attended the 68th annual meeting of the Kansas Academy of Science at Emporia, April 3-5, 1936, and delivered a paper before the Zoölogy Section upon: "Some Factors in the Morphogenesis of Embryonic Epithelia."

Doctor Sauer was born in Lawrence, Kan., in 1903, and graduated from the Lawrence high school in 1922. He took his bachelor's degree at Stanford University in 1926, receiving Phi Beta Kappa honors, and taught political economy at Santa Clara University, Cal., for three years.

In 1929 Doctor Sauer returned to Kansas to further his study in the field of medicine at the University of Kansas. He took a master's degree in anatomy in 1931 with Sigma Xi honors and the degree of doctor of philosophy in anatomy in 1934. While studying for his advanced degrees Doctor Sauer

was a member of the staff of instruction of the University of Kansas. He taught at the University of Wichita in the spring of 1933 and became assistant professor in the fall of 1934. He was married in August, 1934, to Doctor Mary Elmore.

Doctor Sauer was extremely versatile in his ability, and his knowledge was both extensive and detailed. His special field was microscopic neural anatomy and his work on the histogenesis of the nervous system has attracted wide attention and commendation. He was a genius in his knowledge and use of the miscroscope and understood its theory thoroughly. Much of his unusual and careful observation in cellular structure was due to his own inventions and ability to apply the principles in illumination to his work. As a younger man he ground his own lenses and even made a telescope.

Much of his spare time was devoted to research, but he was never too engrossed to discuss problems relating to the general welfare of both the university and the student. He was especially interested in the welfare of the individual student, and many have shared his generosity.

Although upon the campus of the University of Wichita less than five semesters, Doctor Sauer formed a wide circle of friends both in the faculty and the student body. He sponsored a fencing club, read three languages other than English, loved music and art, and was widely read in both science and literature.

With just thirty-three years of life, a marked impression has been made upon our scientific thought and progress.

His publications:

Sex differences in the proportion of the cortex and the medulla in the chicken suprarenal (with H. B. Latimer). Anat. Rec., vol. 50, No. 3, 1931.

Using a "dry" microscope objective on uncovered objects. Science, vol. 78, No. 2032, 1933.

Mitosis in the neural tube. Jr. Comp. Neur., vol. 62, No. 2, 1935.

The cellular structure of the neural tube. Jr. Comp. Neur., vol. 63, No. 1, 1935.

Interkinetic migration of embryonic epithelial nuclei. Sent March 15, 1936, and accepted for publication in the Jr. Morphology.

Three other papers are in manuscript, but are to be finished and published by his wife.

HAZEL E. BRANCH.

REPORT OF RESOLUTIONS COMMITTEE

Resolved, That the members of the Kansas Academy of Science extend:

1. Our thanks to K. S. T. C., Emporia, for the splendid facilities and hospitality furnished during the 1936 meeting.
2. Sincere appreciation of the good work and interest of F. U. G. Agrelius and A. G. Stroud, comprising the local committee, who have made arrangements for this well-managed meeting.
3. Our gratitude to Prof. Geo. A. Dean for his lecture "Practical Use of Insects for Control of Insect Pests and Noxious Weeds"; to President T. W. Butcher and K. S. T. C., Emporia, for the very interesting and instructive sound picture "The Human Adventure," and to the Hon. William Allen White for his lecture on "Glimpses of the Orient."
4. We realize the importance of the publication committee and thank them for the splendid volume containing the TRANSACTIONS for 1935.
5. Appreciation to the state for printing the TRANSACTIONS and to President W. J. Baumgartner for his effective coöperation.
6. Appreciation to the educational and scientific instrument companies for use and exhibits of projection and other scientific apparatus.

(Signed) H. E. CROW, *Chairman.*
J. C. BATES,
R. K. NABOURS,
Committee.

(Prepared by L. C. Wooster, Emporia)

1. Topeka, 1868
2. Topeka, 1869
3. Lawrence, 1870
4. Leavenworth, 1871
5. Manhattan, 1872
6. Lawrence, 1873
7. Topeka, 1874
8. Topeka, 1875
9. Topeka, 1876
10. Topeka, 1877
11. Topeka, 1878
12. Topeka, 1879
13. Topeka, 1880
14. Topeka, 1881
15. Topeka, 1882
16. Topeka, 1883
17. Topeka, 1884
18. Manhattan, 1885
19. Emporia, 1886
20. Topeka, 1887
21. Leavenworth, 1888
22. Wichita, 1889
23. Lawrence, 1890
24. Ottawa, 1891
25. Atchison, 1892
26. Emporia, 1893
27. Manhattan, 1894
28. Lawrence, 1895
29. Topeka, 1896
30. Baldwin, 1897
31. Topeka, 1898
32. McPherson, 1899
33. Topeka, 1900
34. Iola, 1901
35. Topeka, 1902
36. Manhattan, 1903
37. Topeka, 1904
38. Lawrence, 1905
39. Topeka, 1906
40. Emporia, 1907
41. Topeka, 1908
42. Ottawa, 1909
43. Topeka, 1910
44. Pittsburg, 1911
45. Topeka, 1912
46. Baldwin, 1913
47. Topeka, 1914
48. Topeka, 1915-6
49. Topeka, 1917
50. Lawrence, 1918
51. Manhattan, 1919
52. Pittsburg, 1920
53. Lawrence, 1921
54. Manhattan, 1922
55. Lawrence, 1923
56. McPherson, 1924
57. Manhattan, 1925
58. Winfield, 1926
59. Lawrence, 1927
60. Wichita, 1928
61. Manhattan, 1929
62. Hays, 1930
63. Lawrence, 1931
64. McPherson, 1932
65. Manhattan, 1933
66. Wichita, 1934
67. Lawrence, 1935
68. Emporia, 1936

REPORT OF NOMINATING COMMITTEE

President, Lawrence Oncley, Southwestern College.
First Vice-president, George A. Dean, Kansas State College.
Second Vice-president, W. H. Schoewe, University of Kansas.
Secretary, Roger C. Smith, Kansas State College.
Treasurer, H. A. Zinszer, Fort Hays K. S. C.

Executive Council:

W. J. Baumgartner, University of Kansas.
H. H. Hall, K. S. T. C., Pittsburg.
W. B. Wilson, Ottawa University.

Editorial board, associate editors (3-year terms):

E. O. Deere, Bethany College.
W. W. Floyd, Ottawa.

(Signed) W. B. Wilson, *Chairman,*
J. B. Hershey,
J. H. Doell,
Committee.

PLACES WHERE MEETINGS OF THE NATURAL HISTORY SOCIETY AND THE KANSAS ACADEMY OF SCIENCE HAVE BEEN HELD

SUMMARY OF MEETINGS

Topeka	26	Ottawa	2
Lawrence	11	Baldwin	2
Manhattan	9	Pittsburg	2
Emporia	4	Hays	1
McPherson	3	Winfield	1
Wichita	3	Iola	1
Leavenworth	2	Atchison	1

PAPERS AND ABSTRACTS

SIXTY-EIGHTH ANNUAL MEETING, EMPORIA, 1936

Presidential Address:

The Cell in Growth and Reproduction*

By W. J. BAUMGARTNER, University of Kansas, Lawrence

Ever since men began to think, they have asked themselves many puzzling questions about life. Of these there are two which recur constantly: "How does the acorn get to be the mighty oak?" or, "How do things grow?" and, "Why does Johnnie look like his father?" or, "How do things reproduce?" Early man could give no adequate answer; all he could do was to spin hazy theories about earth, air, water and fire, constituting life. Not until two Dutch spectacle makers named Janssen played with lenses and combined them into complex systems did men have any means of finding out much about the constituents of living things. About 1590 these two inventors, father and son, made compound microscopes. At first their primitive instruments magnified only 10 to 20 times, but they became quite popular and scientists began to use them. Harvey looked through a "perspiculum," as he called it, and saw the circulation of the blood. The well-to-do bought the lenses and made a popular sport of watching the jumping fleas, and so they received the name of "flea glasses."

But soon scientists found the lenses useful in their serious studies. Malphigi, an Italian who lived from 1628 to 1694, probably did the most careful work with this early instrument. He used it to examine everything upon which he could get his hands. He really started the microscopic anatomy of plants and animals. He was the first to recognize the liver and the kidneys as glands and to discover the capillaries. He saw and described the lymph nodules in the spleen, to which his name is still attached. In 1665 Robert Hooke, an Englishman, using one of these microscopes, saw little cubicles in corkwood and gave us the word "cell."

During these same years another Hollander, an unschooled lensmaker named Leeuwenhoek, greatly improved the compound microscope, making some that magnified 270 times—about as much as our present low-power combinations. He saw many of the minute plants and animalcules in stagnant water. He described the male fertilizing elements and called them spermatozoa, or sperm animals. Another Hollander, De Graaf, discovered important structures in the ovary. Swammerdam, a fourth Dutchman, described many other anatomical details, particularly those in insects. As a result of this intensive work much of the minute structure of plants and some of that of animals was described before the end of the seventeenth century.

After this first group of enthusiastic workers died, little was done with the microscope for over one hundred years. The reason for this decline is to be found, no doubt, in the ineffectiveness of these early instruments. They were all chromatic; that is, they gave a shimmer of rainbow colors around every object observed. This greatly interfered with clear vision and accurate interpretation. In the later part of the 18th century a Swedish professor, Sam-

Trans. Kansas Acad. Sci. 39, 1936.

* This address was given as an introduction to the showing of a moving-picture film of living cells going through the stages of growth and division. The cells were taken from the testes of grasshoppers.

uel Klingenstierna, and an English mechanic, Dollond, found a method of making achromatic lenses. These prevented the shimmer of colors, and in 1827 an Italian, Amici, first demonstrated the use of the wonderful new lenses in a microscope. He and Chevalier, in France, soon made excellent instruments, and the workers in the universities could at last study adequately the finer structures of the higher plants and animals.

New discoveries followed rapidly. An Englishman named Brown discovered the nucleus in 1831. Scores of German scholars worked on plants and animals, on hay infusions and cultures. In 1838 a botanist, Schleiden, made the statement that all plants and their various parts are built up of cells. The next year a German zoölogist, Schwann, said, "all organisms, both animal and plants, are composed of essentially like parts; that is, of cells." Thus was born the well-known cell theory, called by Dr. E. B. Wilson, professor emeritus at Columbia University, and the greatest living cytologist, the greatest biological discovery ever made next to Darwin's evolution.

The cell theory had a greater immediate effect than the doctrine of evolution because it attracted more workers. With the statement that all living things were made up of cells began that series of microscopic studies which is still going on, which has added many sciences to our list, and from which has come so much good for humanity. Constantly increasing numbers of young students used the microscopes upon all manner of objects, but much had still to be learned. Although Schleiden and Schwann had said that all organisms were made up of cells and established the cell as the unit of structure, they thought of cells merely as small cubicles which had condensed or crystallized out of primitive sap. It took twenty years of work before the turbulent Virchow could convince scientists of his doctrine that every cell comes from a previous cell. It took twenty-three years before Max Schultze, in a short essay, established the fact that a cell is a mass of protoplasm with a nucleus, and not a hollow-walled cavity. Henle founded animal histology upon cells. Mohl described protoplasm and based plant anatomy upon the cell.

Embryology had been much discussed for hundreds of years. However, the interpretation of the huge ovum as the female half-cell, and the minute spermatozoa as the male half cell, and their union to form a new cell, the beginning of the new individual, was necessary before embryology could become a science. And although physiology was the subject of study among the ancients, it took an entirely new trend with the discovery of the cell. Virchow established cellular pathology, thus basing the study of disease upon the cell by about 1870. Soon thereafter followed the rapid developments in bacteriology. Out of the study of minute animals and plants came protozoölogy and protophytology, with their additions of thousands of new species. And the discovery of some of these minute forms as parasites has added the important division of parasitology with its bearing upon the health and welfare of man. The study of evolution, which was for long the *summum bonum* of all inquiries into life's problems, is now also based upon the changes in details in cells. Only last week a taxonomist in our university laboratories came to a cytologist to get help in differentiating two species. Some species differ only in the chromosomes of the cells.

The experienced ecologist of today recognizes that plants and animals can become adapted to their surroundings and to each other only as the cells of

each become properly differentiated and suited to the new conditions. Modern psychology relates its theories of behavior pattern upon the varying conditions in the cells. Biochemistry, biophysics, and biomathematics, the newest subjects to attack the conundrums of life, while they go far beyond the cell in their analyses, yet recognize that the cell is the last division of an organism which can act as a unit. It is the cell which makes the biochemist's or biophysicist's machine, and while he may divide the cell into molecules and atoms or into ions and protons, he knows life's unit is the cell. He further knows that he does not reproduce life's phenomena if he divides beyond the cell. We may, indeed, say that the cell is the basic unit of all biological study.

The study of the cells has developed the science of cytology pertaining to both plants and animals. This science, since about 1870, has specialized in the details of behavior of the smaller parts of the cell; the nucleus, the chromosome, and, more recently, the gene. The first concern was to follow the manner of action of these parts in cell division. Although the process had been seen by Nägeli in 1842, the details of the phenomenon were not well understood until in the later eighties and nineties, when mitosis was acknowledged to be the prevailing method of cell division. Cell mitosis now gave a real basis for explaining one phase of the growth of organisms and much more light could be thrown upon the question of how the acorn becomes the oak.

One part of the cell, the so-called chromosome, has received the most attention. After about thirty years of effort on the part of hundreds of microscopists, scientific men were finally convinced that the number of chromosomes in every species is constant and that they are continuous from one cell to the next cell and from one generation to the next. Scientists are further convinced that the chromosomes in cells occur in pairs and that in the formation of new germ cells these pairs are fused, then are halved and distributed to the ovum and sperm in half the number found in the body cells. These discoveries gave a material basis for the interpretation of reproduction.

At the opening of this century two Kansans, Dr. C. E. McClung and the late Dr. W. S. Sutton, gave cytology two discoveries of greatest importance. The former interpreted an uneven chromosome as the sex chromosome and the latter suggested that the paired chromosomes in every cell represented the paternal and maternal characteristics as marked out by Mendel. The hundreds of workers following after them have confirmed these fundamental observations and have added to the evidence that the paired chromosomes represent in a definite way the paired opposing characteristics of father and mother. At last there was some hint as to why or how Johnnie happens to look like his father.

This mutual coöperation and interlocking of the study of the chromosomes and the genes has been called the marriage of cytology and genetics. It has been asserted by many scientists, who are not themselves biologists, that the combination of these two scientific disciplines produced in the first third of the present century more good for humanity than any other scientific developments during the same period. So much must be admitted, namely, that, as a result of the studies made, we know enough about the inheritance of characteristics to have improved the quality of most of our domesticated plants and

animals. Possibly, when we are willing to apply the knowledge we have to man, we can improve even the human stock. In a few states, notably Kansas and California, we have made a feeble beginning by making unproductive some of the obviously unfit. Some other nations have already begun more ambitious programs of racial improvement.

Nordenskiöld, in his fascinating account of the history of biology, has emphasized the importance of microtechnique as an aid to the microscopists from about 1860 to the present day. Very many modern discoveries are the result of finding a better fixative or a better stain. In 1870 William His invented the microtome and, by producing uniformly thin serial sections, this machine has made possible countless discoveries previously impossible. However, these processes of fixing, sectioning, and staining have also introduced some uncertainties into the work of the cytologists. Many have been the charges that the chromosomes or the division figures were only artefacts and represented nothing real in the animal or plant. Well do I remember that in my early graduate days the famous Jacques Loeb said: "Oh, yes, cells exist and possibly nuclei, but all the other things said to be in living tissues are just precipitates caused by the chemicals used in fixing or staining." Life to Loeb was only solutes and precipitates.

Upon another occasion in my early graduate years I met the now famous American Nobel prize-winner, Thomas Morgan. When I told him I was working in cytology, trying to find out more about chromosomes, he said, "Working in cytology on chromosomes, young man, you are up a blind alley. Get out into some other line where you can get somewhere." But within fifteen years Morgan and his students were breeding fruit flies by the millions and mapping chromosomes to locate the relative position of the genes which carry the inheritable characteristics. Morgan's great international reputation is based on genes located in the chromosomes he scorned. This incident illustrates how uncertain it is for any scientist to attempt to diagnose what is going on in his own time and to say what is coming in the immediate future. But this is always a great temptation.

One way in which we can get a glimpse of current trends in any one branch of science is by glancing at the titles of researches which are given at the annual meetings of the various groups of specialists. If we scan the lists from recent meetings of cytologists and students of growth we see that the study of fixed material is largely passing. Living tissue studies with photomicrography, with ultraviolet light, or with microdissection, or experimentally with various chemicals or physical modifications, the X ray for example, are supplanting the older methods of study. Checking the titles of the "Cold Springs Harbor Symposium on Quantitative Biology," we find out of thirty-two titles, twenty-one which deal with some chemical effect upon the cell, four concerning the gene and cell growth, and only seven which do not touch on the cell. Taking at random fifty papers in the *American Journal of Anatomy,* forty-one of them deal with cell changes in growth or cell differentiation.

Thus, having surveyed the past and briefly inspected the present trends in the study of the cell, we may say that we know that the acorn becomes the oak because cells divide by mitosis and then while they 'rest,' as we say, they take up exogenous material and build up new protoplasm and differentiate it into leaf or woody stem, into hay or cotton, grain or fruit. And in the animals

other cells divide, and then while they 'rest' they build up more protoplasm which differentiates for our use the convenient hand, the strong back, the seeing eye, or the knowing brain. Still other cells in the plants and animals fuse their chromosomes, thus mixing their genes, and then divide twice and differentiate into the ovum and the sperm. These unite and a new Johnnie may grow up to look like his father.

But is that all? What of the future? What more shall the microscopes teach us? Or what new instruments will we have? As Furnas so aptly says in his recent book entitled *What about the next one hundred years?* "What about the unfinished business of science?" As we look back on the state of our knowledge in 1800 we have learned much about growth and reproduction, but if we face the facts of 1936 we have much to learn. What constitutes life is as much a mystery as ever.

In 1828 Wöhler synthesized urea and thus proved that living material is not essentially different from nonliving. Biochemists have synthesized the sugars and other carbohydrates and some of the simpler proteins which make up protoplasm, the basic substance of living things. More of these proteins are being made each year from simpler products. Some of the proteins are known to have molecular weights of 34,000, that is, they are 34,000 times as heavy as the hydrogen atom. And how large the largest ones are no one knows. Remember as well, that there are thousands of these proteins in protoplasm. So we are a long way from solving the problem from the chemical aspect.

Moreover, every time protoplasm is analyzed it is *dead* protoplasm in a more or less stable form. To analyze living protoplasm will require the development of an entirely new technique. The attacks upon the problems of living protoplasm are today being made from at least five angles; first, through a study of the vitamins; second, the hormones or endocrine glands; third, mal-differentiations or cancers; fourth, infections or bacteria; and fifth, genes and inheritance. Every one of these has hundreds of investigators working at as many problems, and often from more than one approach, for separating lines are no longer sharply drawn. Let us try to look very briefly at those which most concern our problems of growth and reproduction. The vitamins and hormones are thought to influence the growth of the acorn into the oak and the hormones and the genes to determine some of the strange observations in reproduction.

Just thirty years ago F. G. Hopkins first noticed that rats, in order to grow normally, needed more that fats, carbohydrates, proteins, and mineral salts, and so foreshadowed the many studies that have followed on the vitamins. Now we recognize at least eight substances which are capable of functioning in as widely different ways as preventing a disease like scurvy or of fostering reproduction. Some of these vitamins have been analyzed, synthesized, and crystallized. Of others we know little, save that they need be present in minute traces but are absolutely essential—the cells of certain organs being unable to function without them. How many other vitamins remain to be discovered, what cell growth effects will be traced to them, and how they work are all questions for the future to answer. But until they are answered we shall not know just how a cell increases its protoplasm.

One two thousandths of an ounce of thyroxine stands between Einstein and imbecility says Furnas in his characteristically popular style. Thyroxine, an extract of the thyroid gland, is a hormone, an amino-acid derivative having the formula $C_{15}H_{11}NO_4I_4$. It is a protein-like substance which controls, supervises, and regulates food assimilation and energy distribution in the body. Proper food and energy control makes an Einstein but thyroxine has other only half-understood functions as well. The hormone acts, although it is distributed in the body in only one part in 4 or 5 million. Another hormone of the pituitary gland still acts when present only in one part in some 30 or 40 billion.

Not only the nervous system, as was taught only a few years ago, but the hormones of some eight or more of these internal secretions glands bring about proper coöperation of the various parts of the body. A slight trace of a secretion from a cortical cell in the adrenal gland will greatly influence the circulation in other parts of the body. Just how many of these secretions there are we do not know, but the cells in the endocrine glands have the different parts of the body regulated in a manner better than Mussolini regulates his troops. Some 15 to 25 hormones of the endocrine glands are said to control the heart and respiratory rate. Others tell us when to start growing and when to stop. They see that our food is properly handled. They cause hair to grow on a man's face and prevent it from growing on a woman's. They urge organisms to reproduce and take charge of proceedings at the birth of the offspring and during nursing. Indirectly they affect mental activity, the size of the feet, the degree of obesity and they may control our very personalities. These hormones secreted by certain cells govern the activity of cells in all other parts of the body. But how? We do not know. Hundreds of biochemists and physiologists are at work today but progress is very slow. We do know that if some ghost should suddenly impress the rod and cone cells in the eyes of a small boy certain nerve cells carry the impression to his brain, other nerve cells here interpret the impression as fearful, then other nerve cells will carry a message to the cells of the suprarenal, which cells in turn will send a hormone to the muscle cells of the legs and the small boy will run like a deer. At another time, certain cells in the pituitary gland of a twelve-year-old lad who has grown hardly at all for several years will secrete a certain hormone which is carried about the body and the boy becomes a man in a couple of years. Cells have formed hormones which have caused other varieties of cells to form new protoplasm rapidly and also to divide rapidly so that we can partially explain the growth which characterizes adolescence.

Stock breeders, by selecting the right mothers and fathers, have produced the modern dairy cow, an animal with a large food pouch and a full udder. By selection of pigs they have brought forth the almost-boneless ham, and by selection of the chickens, the perennial layer of eggs. Wheats are produced that will not winter-kill, others which are especially smut-resistant. Seedless fruits can be bred. By selection all kinds of improvements can be produced in both plants and animals. Variations can be caused by crossing races and producing hybrids, other changes can be induced by X rays. And these changes can be followed in the chromosomes and the genes. By proper breeding and selection breeders get what they want.

When we come to man and the higher mammals, the genes are probably more

complex and more numerous and the breeding rate is so slow that we have no satisfactory data on the behavior of most characters. We do not know that genius is inherited, but we do know that many, if not all, of the bodily characters and many mental defects are inherited. In the reproduction of individuals the germ cells carry certain genes or characteristics so that as the result of certain combinations Johnnie will look like his father. But as he grows older certain hormones play their part in his development and Johnnie may become more or less like his sire.

In order to make a little clearer what is happening in the fascinating processes concerned in the growth and reproduction of living protoplasm I am going to show you a moving picture of the division of cells within the testis of a grasshopper. Here we can watch one cell as it forms two cells, demonstrating the actual growth of protoplasm. Again we focus on the chromosomes as they divide, equally distributing genes to the newly forming cells, and we have witnessed the fundamental processes involved in reproduction and inheritance.

Fat as a Factor in Palatability of Beef[1]

DAVID L. MACKINTOSH and J. LOWE HALL, Kansas Agricultural Experiment Station, Manhattan.

Historical

As early as 1750 the animal breeder gave at least some thought to the eating qualities of his product, thereby gaining a basis on which the modern breeds of meat-producing animals have been developed. Even at that time his thoughts were trained on tenderness and juiciness of the meat as measured by the palate, but no definite method was used to measure the degree of palatability. Not until about 1885 (*6*) was there any actual attempt made to measure the difference in palatability that might result from different methods of feeding these improved types of animals. However, these investigations on palatability were soon dropped in favor of studies relating to economy of production. It is true that a few studies of carcasses were made in the years that followed, but not until 1924 was there any concerted effort on the part of animal husbandmen to analyze the quality and palatability of meat (*4*). In that year the U. S. Department of Agriculture and a number of state experiment stations undertook a coöperative study relating to quality and palatability of meat, which was well under way by 1926. The past ten years have brought to light many interesting facts, not known previously, relating to quality and palatability of meat. Many ideas formerly considered as facts have been "debunked" and many more substantiated by experimental evidence.

Statement of Problem

The price of beef is based at least to a certain degree upon grade, and the grade is determined by the conformation, quality, and finish of the carcass (*3*) or wholesale cut. Since the last-mentioned characteristic, finish, is the only one to be considered here, no attempt will be made to define the other two terms. By finish is meant the degree of fatness of an animal and the degree of fatness is determined by the thickness of the outside covering of fat over the carcass, the amount of intermuscular fat and the amount of marbling (Figs. 1 and 2). Intermuscular fat refers to that fat deposited between the muscle layers, while marbling refers to the fat distributed through the lean muscle which gives to the muscle a "marbled" appearance.

For at least two centuries the animal husbandman has been interested in fattening his livestock. His endeavors along this line have been stimulated by the higher price paid for the fat animal because it was believed that added increments of fat improved the desirability of the meat. However, this increased desirability, while acknowledged by most meat-eating people, was not based on experimental evidence. It is true that the added fat does improve the appearance of the meat. This is chiefly because the consumer has been taught to appreciate the combination of bright red muscle with hard white fat. He has also been taught that the fat modifies the palatability of the meat after cooking. On the other hand, many present-day housewives consider most of the outside fat and the separable fat a table waste that

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1. Contribution No. 120 from the Department of Animal Husbandry, and No. 207 from the Department of Chemistry. Coöperative meat project, Purnell 165.

could be eliminated. The lean muscle is of primary interest to the consumer. Therefore, one of the questions for which an answer has been sought is the influence of finish, or fat, upon the quality and palatability of the lean muscle.

EXPERIMENTAL

The data presented here have been accumulated during the past ten years in the meat laboratory of the Kansas Agricultural Experiment Station as a part of the coöperative study with the U S. Department of Agriculture and other state experiment stations. The animals used were cattle of different ages fed under varying conditions, fattened on different rations, and then

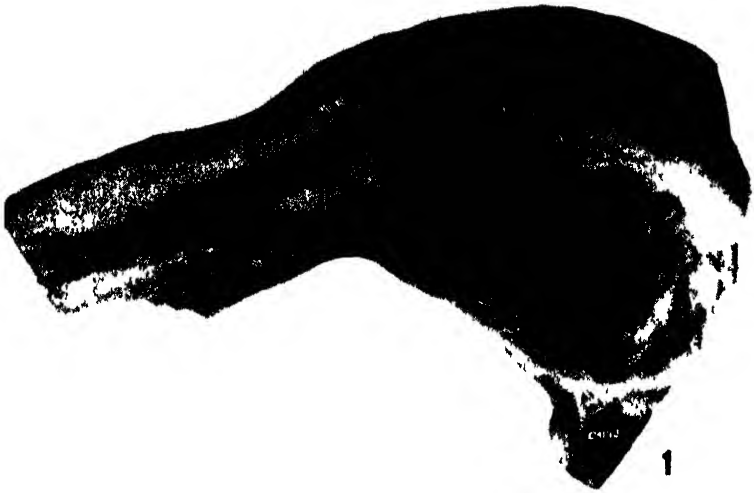

FIG. 1. Beef rib with ample external covering, marbling abundant, grading choice and tender.

slaughtered in the station laboratory. All carcasses were carefully graded by a committee using the standard grading chart (2), on which were recorded the degree of outside covering of fat, the intermuscular fat, and the marbling. The marbling was observed in a cross section of the longissimus dorsi muscle from between the 12th and 13th thoracic vertebrae (Fig. 3), at the time of "ribbing" or quartering the carcass. The ninth to eleventh rib roast was selected by all of the coöperators as a standard cut for further analyses (*5*). This roast from one side of the carcass was separated into mechanically separable fat, lean, and bone; and the "eye" or longissimus dorsi muscle was used for chemical analyses and other studies. The corresponding rib roast from the opposite side of the animal was used for palatability tests. These roasts were cooked[2] under carefully controlled standard conditions and the palatability measured by a committee, the members of which were highly trained. They recorded their observations on a grading chart (*1*) which gave

2. All cooking was done by the Department of Foods and Nutrition of the Division of Home Economics.

special consideration to tenderness, flavor, and juiciness. These three properties of meat appear to be the ones to which the palate is most sensitive.

Wherever possible, mechanical and chemical tests have been used to supplement the observations of the palatability committee. Some of these have already been fairly well worked out, while many others are in the process of trial. The Warner-Bratzler mechanical shear (Fig. 4) developed at the Kansas station with the coöperation of the U. S. Department of Agriculture, and now considered a good means of measuring tenderness of cooked meat (7), has been used in part of this work. At the present time the Carver press is being used as a means by which to measure juiciness, but sufficient data are not yet available to determine the reliability of this method.

FIG. 2. Beef rib deficient in external covering and marbling, grading medium and tough.

Some of the measurements relating to degree of finish made at the Kansas station have been correlated with the palatability factors and are summarized in Table 1.

TABLE I —Factors Correlated

Marbling, as measured by grading chart, correlated with:	Number of carcasses	Correlation coefficient.
Mechanical shear (cooked sample) .	63	650 ± 0516
Tenderness (palatability committee)	61	675 ± 0471
External covering (grading chart)	105	815 ± 0438
Mechanically separable fat	105	319 ± 0594
Juiciness (palatability committee)	104	558 ± .0456
Flavor intensity (palatability committee)	104	587 ± 0433
Flavor desirability (palatability committee)	86	488 ± 0571

Discussion

The data presented in this table show a highly significant correlation between the external covering of the carcass and marbling. Marbling seems to be closely related to tenderness as measured by both the mechanical shear and the palatability committee. It also appears to be associated with both juiciness and flavor as measured by the palatability committee.

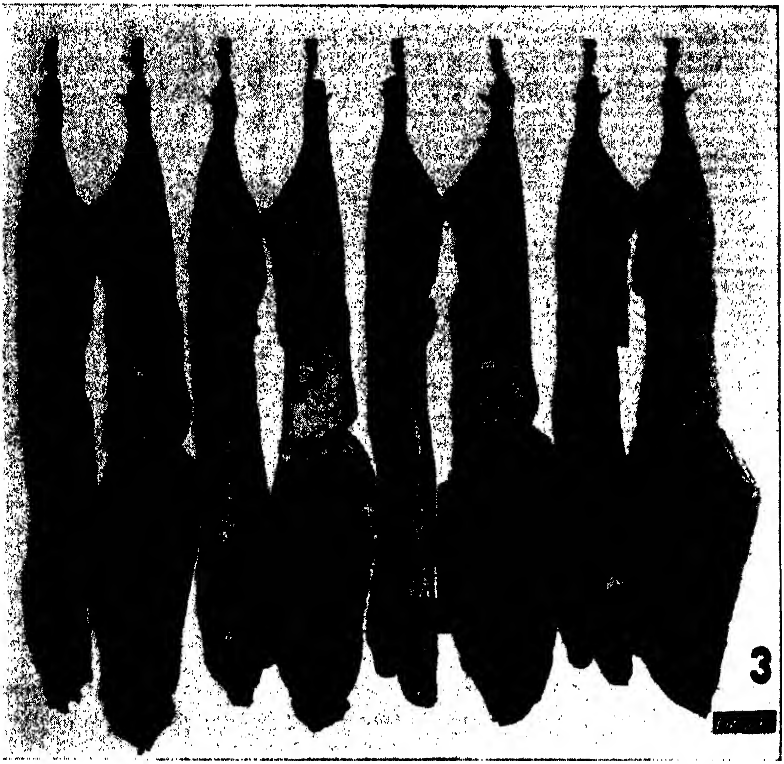

Fig. 3. Beef carcasses, left side ribbed for grading.

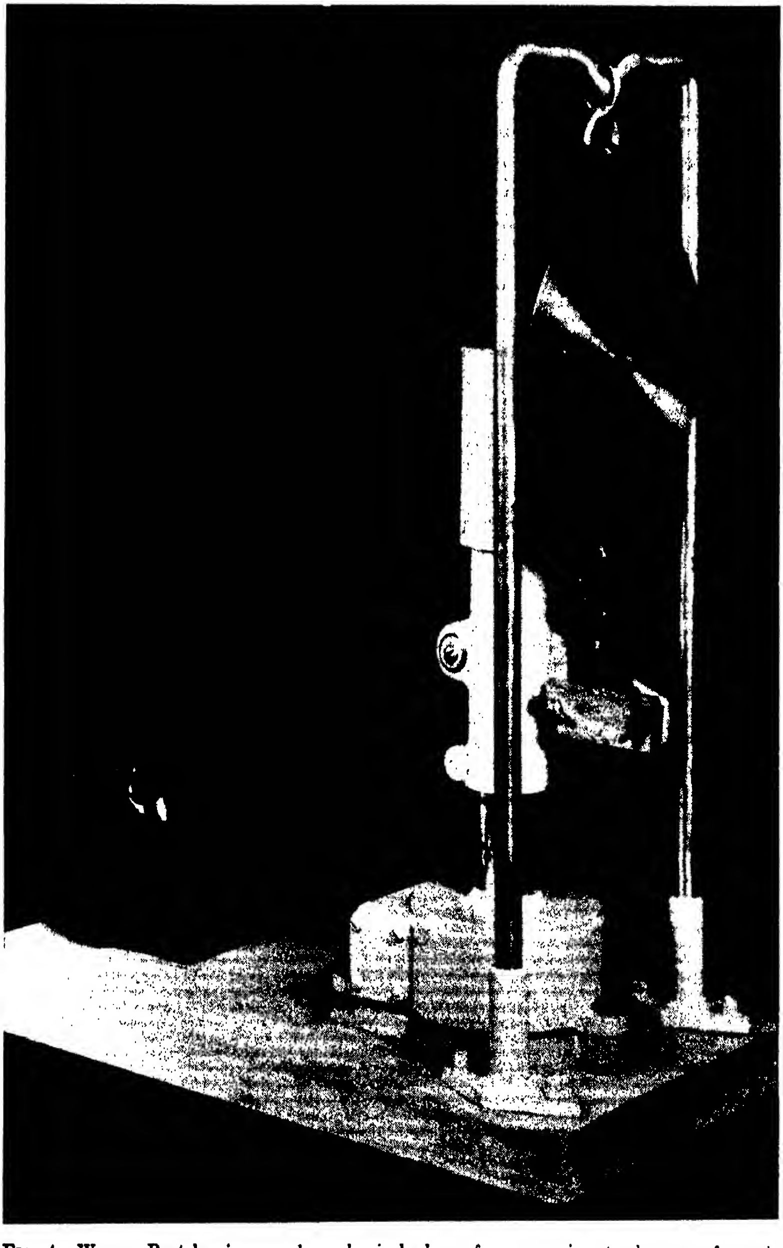

FIG. 4. Warner-Bratzler improved mechanical shear for measuring tenderness of meat.

Conclusion

Degree of finish or fatness of beef appears to be associated with palatability. An increasing degree of finish renders more intense the properties of tenderness, juiciness, and flavor. It should be noted, however, that exceptions to the general rule appeared among the experimental animals, and these will continue to appear. But the evidence seems to justify the old-time belief that fat improves the palatability of the meat. Without a doubt, there is a point beyond which increased increments of fat will not improve the palatability. This point has not yet been determined, but it is well beyond the degree of finish found on most market cattle. The practice of fattening animals for market, as well as the higher market price paid for fat animals, seems to be well justified.

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Botanical Notes, 1935

FRANK U. G. AGRELIUS, Kansas State Teachers College, Emporia, Kan.

A little thought will convince one that the living organisms of today are those that have been successful in meeting all the tests of endurance to which they have been subjected since the origin of life on the earth. The highest flight of the imagination cannot possibly picture or conceive what all of these conditions may have been. Living things are influenced by innumerable other things and conditions, these in turn by numerous others. All are more or less interdependent, and when one endeavors to measure the total of the influences affecting any plant or animal he is glimpsing infinity.

We will first note conditions near or about the home. The smaller Chickweed (*Cerastium brachypodum*) has more than held its own. It has ruined bluegrass lawns and is extending relentlessly into more lawn and garden areas. We fear that removal of the turf and reseeding will not help much because of the abundant seed in the soil. The larger Chickweed (*Cerastium nutans*) is abundant in damper places.

Henbit (*Lamium amplexicaule*) is rapidly becoming one of our worst plant pests. It has increased greatly in the last few years and has completely occupied some of the parkings, and is also in some lawn areas. It, also, is difficult to eradicate.

Tribulus terrestris, so-called buffalo bur, puncture vine, and other names, is truly diabolical in its doings and attributes. Intelligent efforts might have prevented its spread, and without much difficulty, too.

Until the last season, the cedar apple rust has been very evident on the red cedars and the common apple and its relatives. At this writing, in the spring of 1936, there is less of it to be seen on the cedars. In our opinion, the two exceptionally hot, dry summers have been factors in lessening this evil.

The trees lining our streets in Emporia have suffered greatly from a combination of circumstances. Weakened by previous defoliation and drought, they started the year in bad condition. The defoliation was not as severe, but they suffered from the heat and drought and heavy infections of plant lice and red spider. Many elms have died and others were badly damaged. Other trees, including silver maple, ash, boxelder, and some of the evergreens, have died, but for somewhat different reasons in part. Heat and drought were the chief causes. In the forests some of the above-named trees and the oaks, principally bur oak, sycamores, ashes, hickories, and especially red elm, have died in numbers or are seriously weakened. A contrasting condition exists in the evergreens that survived the misfortunes of the summer. The pines, cedars and arborvitaes are in the most thriving condition noted for some years, due probably in part to the abundant moisture in the soil at the beginning of winter.

After several years of scanty showing, the burning bush (*Chaenomeles lagenaria*) and the golden bell (various species of *Forsythia*) made a magnificent showing. To the various colors of the burning bush, mostly red or scarlet, was added numerous splashes of the yellow of the Forsythias. Coming so early in the season, they were especially welcome.

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Going countryward, many items were noted. The pestiferous bindweed (*Convolvulus arvensis*) is becoming more widely spread, due in part to the dragging of the highways and the transfer of earth from place to place. On the other hand, the attractive wild verbena (*Verbena bipinnatifida*) made a fine showing for an extended season. We welcome the latter heartily.

The golden rods were fewer than common, while prairie asters were plentiful and attractive. Snow-on-the-mountain (*Euphorbia marginata*) was abundant and pleasing in appearance. Some of the blazing stars were less common than usual, but one species, *Liatris punctata,* outdid itself. The green milkweed (*Asclepiodora viridis*) was the most noticeable occupant of some of the too closely pastured grasslands.

An item somewhat disconcerting to the stockmen has been the harm done to the flint-hill pastures through the killing of the big bluestem grass, *Andropogon furcatus.* It has been replaced in spots by the cheats (*Bromus* spp.).

Most farmers were not pleased by the behavior of the common sunflower, *Helianthus annus.* To the lover of beauty, however, this flower, one of the most magnificent that we possess, was a source of wonder and delight. "If this be treason, make the most of it."

Penstemon cobaea, the large beard-tongue, beautified many rocky outcrops in the grasslands.

We have reserved several outstanding items until the last. On the hills southeast of Florence and extending west toward Marion there was a mantle of gold visible at a distance of a mile or more. This was in the pasture land, It reminded one of some pictures of scenes in a western state as shown in one of our magazines recently, and our scene did not suffer by comparison. The golden color was due probably to a species of *Chrysopsis.*

In the vicinity of Emporia there were great fields of lilac pink, rendered so by the countless blossoms of a common smartweed, *Polygonum longistylum.* There should have been plenty of nectar for the bees.

Adding to the stockmen's troubles by the taking of his pastures has been the small plant with a long name, *Amphiachyris dracunculoides.* The farmers call it "broomweed," or believe it to be some form of goldenrod. We think that Miss Helen Schaefer, of the Academy, has given it a very apt name—that of the "Fairy Elm." It closely resembles a red elm except in its size. The outstanding fact about it is that it has increased to a serious extent in the last few years, possibly not in its range but in its numbers. When in full bloom it has made the prairies a gorgeous sight of myriad golden stars, strikingly beautiful to all but the owners of the pastures.

The climax to us, though, was the display made by the blossoms of the prairie wind flower, *Anemone caroliniana.* In previous seasons we have been able to secure a few specimens for use in our classes. But without any previous warning it became in one season what was easily the predominating flower of many prairie areas. To our knowledge there has never been anything approaching such a sudden increase in a plant. The prairies were whitened by a particular color phase and so much so that this was noticeable for considerable distances. Nearer approach brought the other color effects into view, with the rich purple appearing last. To produce these effects there were many millions of plants in the blossoming stage. Where did so many come from? This is a perennial plant. It is probable that the plants have been in place all of

the time, but because of the burning of the grasses many were damaged. Because of the coverage of the ground by other plants, these little fellows were not able to make a showing by blossoming. They could continue their existence, however, and spread somewhat vegetatively through many years. Then, when a peculiar set of circumstances came, it made a Jack-in-the-box appearance.

Kansas is always interesting, but during the past year she outdid herself in many respects.

Notable Trees of Kansas, II

FRANK U. G. AGRELIUS, Kansas State Teachers College, Emporia, Kan., and HELEN I. SCHAEFER, formerly Kansas State Teachers College, Emporia, Kan.

THE TREE THAT WOULD NOT DIE [1]

This is a specimen of *Taxodium distichum*. It is about 65 years old, is about 70 feet high, and has a girth of 5 feet, 9 inches. It stands just east of Old St. Benedict's Abbey, in Atchison, Kan. It earned its title from the following circumstances: For the first 15 years of its life it was "one continuous

FIG. 1. The tree that would not die. A bald cypress, *Taxodium distichum* (L.) Richard, Atchison. Kan. Data by Homer Stephens.

bend and peel." It stood originally on the edge of a deep ravine. In the erection of some buildings it was run down, broken, and peeled several times. Then, when the ravine was filled, materials were dumped without regard to the tree and it was broken and peeled again. It has truly exemplified our state motto through many disheartening trials. It still lifts its head toward the stars, as may be seen by its picture, and is in a thriving condition. (Fig. 1.)

Trans. Kansas Acad. Sci. 39, 1936.

1. Stephens, Homer, Atchison High School, 1936

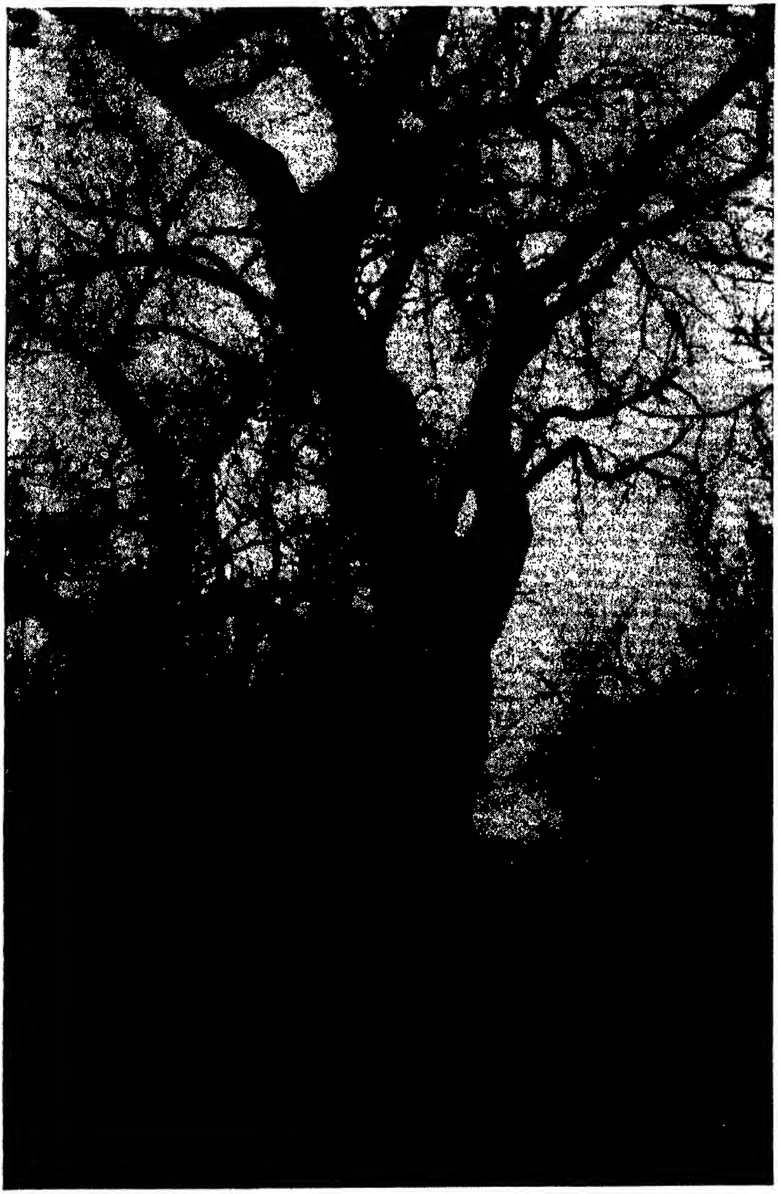


Fig. 2. The Kit Carson elm. White elm, *Ulmus americana* L., Halstead, Kan. Photo by authors.

THE KIT CARSON ELM

This White Elm stands on the east bank of the Little Arkansas river in Riverside Park, Halstead, Kan., and a few rods south of where Black Kettle creek enters this stream. We do not know its age, but it was said to have been a good-sized tree 65 years ago. From this it must be close to the century mark in age. Its present circumference is 12 feet, 9 inches.

Local old settlers assert (*2*) that several fierce battles were fought in its vicinity. Accounts of one engagement that gave the name to the tree differ materially (*3*) (*4*). About the year 1867, Custer and his soldiers engaged in a sharp battle with the Osages and the Arapahoes in a night engagement. Kit Carson, who was encamped under the elm, went to the help of Custer about three o'clock in the morning.

In a second story, Kit Carson and his band of emigrants were encamped here for the night. The Comanches surprised the camp and Kit Carson led in the defense against the Indians, who were commanded by Chiefs Black Kettle and Hard Rope. The ammunition of the whites was running low when Custer and his soldiers arrived on the scene and drove the Indians away. In this same account, the tree is said to have been a landmark for the Osages and Arapahoes.

The variations in these accounts illustrate the fact that there is liable to be distortion of truths, and still present a fairly accurate picture of what happened. At any rate, the public-spirited citizens of Halstead are caring for and cherishing this tree as befits its character and dignity. The metal marker in the picture bears the inscription: "The Historical Kit Carson Tree—1854." (Fig. 2.)

THE POST-OFFICE OAK (*5*) (*6*)

This oak is on the edge of Madonna Park, the site of the campground for trailsmen in Council Grove, Kan. It stood on the limits of a large grove of oaks of which the Council Oak is one, and which is about a block east of the Post-office Oak. Both face the Old Santa Fé Trail. Incoming and outgoing wagon trains left messages and warnings in a cache at the base of the tree for members of the pack trains and caravans that passed this way. This continued from 1821 until 1847 when the trading post, Council Grove, was established. The tree is in front of the old brewery built in 1864 and which is still standing. It is marked with a metal plate, placed on it by the civic-minded citizens of Council Grove. From its pictures and from direct observation, although it shows some disfigurements by diseases, one concludes that it has promise of many more years of life. It seems probable that the Post-office Oak is about 200 years old. It has good claim to belong to the "old settlers' association." (Figs. 3 and 4.)

THE CUSTER ELM (*7*) (*8*) (*9*)

A sad commentary on the power which the economic holds on mankind is to be seen in the stumps of what were once grand old trees, emblems of so much that is worth while and worthy of emulation by man. These were trees that have been sacrificed to the needs, and sometimes the greed, of people. In

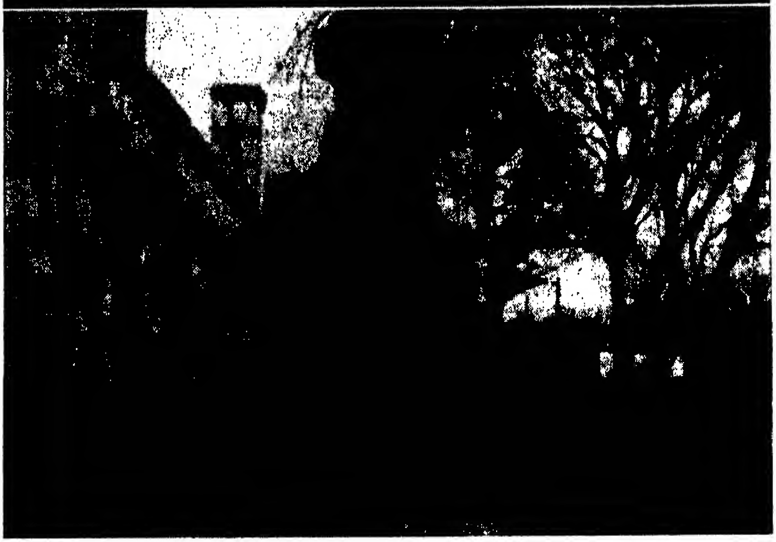


Fig. 3. Post-office oak *Quercus* sp. Council Grove, Kan. On old Santa Fe trail highway 50N. Photo by authors.

Fig. 4. Close-up, from west. Photo by authors.

FIG. 5. Custer elm. White elm, *Ulmus americana* L., Council Grove, Kan. On state highway 13. View from west. By authors.

FIG. 6. Close-up from east. Photo by authors.

a few sacrilegious strokes of the axe, the axeman has felled a noble friend, and so often without thought of the destruction of an irreplaceable landmark. As a result, large numbers of once outstanding and beautiful specimens of the plant kingdom are no more. In many respects, not even time counted in centuries can produce their equals. The Custer Elm very nearly suffered the fate of countless others. As in some other instances, it was saved through the appreciation of its beauty by a courageous and energetic woman, Mrs. W. A. McCollom. She bought it from the man who had planned to cut it down, and secured the passage of an ordinance by the city council of Council Grove forever saving it to posterity.

In 1867, General Custer, with his famous Seventh Cavalry, encamped under this tree and in the adjoining grove while on his way over the Santa Fé Trail. Pleased with the beauty of the scenery and the productiveness of the soil, General Custer purchased 160 acres of land surrounding this tree. Later his widow sold this land. The city extended its boundaries and a street was laid out that included the Custer Elm in its course. Without knowing its historic significance, Mrs. McCollom saved it.

The Custer Elm borders directly on one of the Kaw trails that led out from the trading post of Council Grove. It is close to highway No. 13 and easily visited by those interested in seeing it. It is being properly cared for and possesses a metal marker, as do the two other noted trees of Council Grove. This tree is a large, native white elm, growing in alluvial soil. Its real circumference is 16 feet and 2 inches, while above it is 18 feet and 5 inches. The Custer Elm is attractive in appearance and is in apparent vigor. (Figs. 5 and 6.)

THE OLDEST TREE IN TOPEKA (*10*) (*11*)

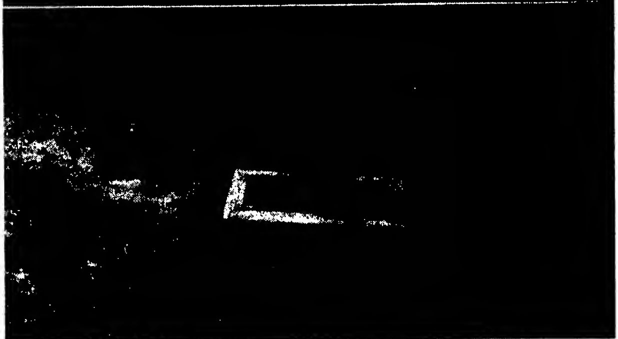
This Honey Locust, *Gleditsia triacanthos*, stands beside what was once an old state road, now known as Huntoon street. It is on the southeast corner of Huntoon and Clay. It is a good-sized tree for this species, being 8 feet 5½ inches in girth.

Reliable authorities state that it was the only tree standing between the Shunganunga creek and the Kansas river in 1860. Mrs. Margaret Hill McCarter learned from the members of the family of Reverend Mr. Steele, the first Presbyterian pastor who came to Topeka in 1860, concerning this honey locust tree, and she has immortalized it in her story, "The Price of the Prairie."

It is now designated by a marker, with the inscription: "Topeka's Oldest Tree Marked 8A Class, May 1913, Central Park School."

This last fact is due to the inspiration and energy of one of this class of 1913, Miss Edna E. Clark, now a member of the faculty of Curtis junior high school in Topeka.

The city of Topeka is caring for this fine old pioneer citizen and it will probably long stand as a reminder of former days and will continue to add to the beauty of our capital city. It is also a reminder of the farsightedness and wisdom and activity of some of our friends of the trees. (Figs. 7 and 8.)



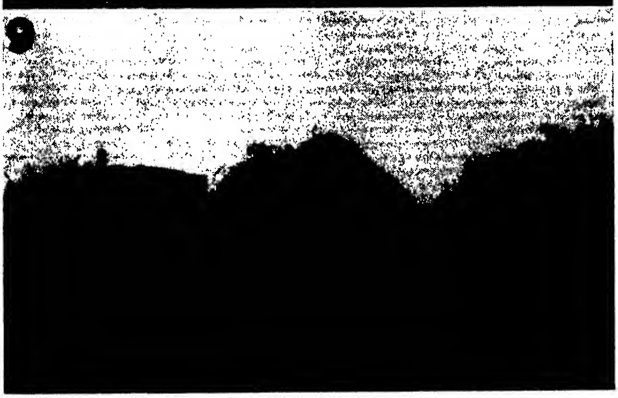


FIG. 7. The oldest tree in Topeka. Honey locust, *Gleditsia triacanthos* L. Corner Clay and Huntoon streets, from west, looking down Huntoon street. By authors.

FIG. 8. Marker at base of tree. Inscription: "Topeka's oldest tree, marked 8a class, May, 1913, Central Park School." Photo by authors.

FIG. 9. The umbrella elm. Camperdown elm. *Ulmus glabra* Huds. var. *camperdownii* Rehd. Growing in the 200 block on Elm street, Eureka, Kan.

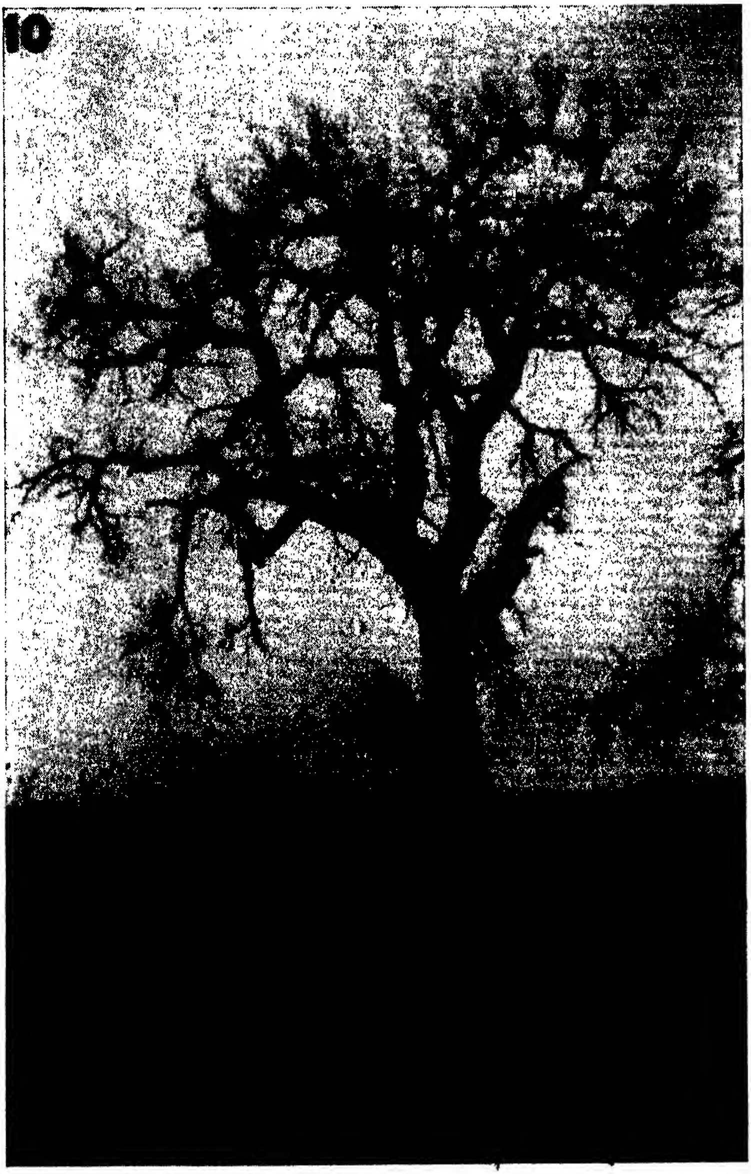


FIG. 10. The Englewood cottonwood. *Populus sargentii* Dode (?). About eight miles northwest of Englewood, Kan. Photo by Miss Noma Dunn.

THE UMBRELLA ELM

The city of Eureka can boast the possession of a strikingly fine specimen of a "weeping elm." Its branches are quite similar to those of the weeping willow and the total result is that of a large umbrella or a monster mushroom.

To those to whom the comical appeals it serves as a reminder of the days when the parents were the barbers for their growing urchins and in order to have a symmetrical result, placed a crock over the boy's head during the operation. This effect is the result of trimming the hanging branches at a definite height from the ground.

This elm is in the block between First and Second avenue on Elm street. (Fig. 9.)

THE ENGLEWOOD COTTONWOOD. (*12*) (*13*).

Our cottonwoods should be recognized appropriately, we believe, in much of the song and story of our state. They have been true pioneers. They have indeed "endured hardness." They exemplified the state motto long before the motto was conceived. They "stood by" faithfully during all the hardships experienced by our state builders.

The Englewood Cottonwood is one of the finest examples of this tree within our boundaries. As its pictures will bear witness, it has faced difficulties, and, though badly disfigured, it is still carrying on.

Through the kindness of Superintendent Turner of the Englewood schools and of Miss Noma Dunn, of Gate, Okla., we have the pictures and accompanying data. It is on the old Beeson ranch, about 8 miles northwest of Englewood. The base is 22 feet in circumference. Its real girth is 19 feet, 2 inches. Its diameter at the base is 7 feet. Its calculated height is 94 feet, 8 inches.

Presumably this same tree is mentioned in several writings. In one instance it is credited with a circumference of 31 feet, and is placed east of Englewood. (Fig. 10.)

AN OSAGE COUNTY OAK

About one half mile northeast of "An Osage County Cottonwood" is an oak, noted in the vicinity for its large size. It would perhaps not be very outstanding were it not that so many of our finest oaks have been sacrificed for their economic value. It is on the W. R. Cook farm and on the west bank of Salt creek. This tree belongs to the "white oak" group. We are not certain, but it probably is *Quercus macrocarpa,*" the Bur Oak. Its circumference was 12 feet, 5 inches. This is large for an oak, and it is evidently of considerable age. It is to be hoped that it may be spared for many years to come. (Fig. 11.)

AN OSAGE COUNTY COTTONWOOD

People who live in the neighborhood southeast of Osage City often see a cottonwood tree that towers above its neighbors. It is noted for its height and for the beauty of its straight trunk. Although marred by damage from lightning on its northern side, viewed from the west it is a beautiful specimen. The first limb is approximately half way to the top. This gives it a

trim appearance. Viewed close, its deeply furrowed bark is quite striking and is characteristic of this species of tree. Its position in the forest does not allow the taking of a satisfactory picture. It is the central tree in the figure.

This cottonwood stands on the Harry Smith place, five miles southeast of Osage City. Its circumference is 12 feet, 1½ inches. Its height, calculated by Charles Allegre, is 112 feet. This is the tallest cottonwood of which we have knowledge. (Figs. 12 and 13.)

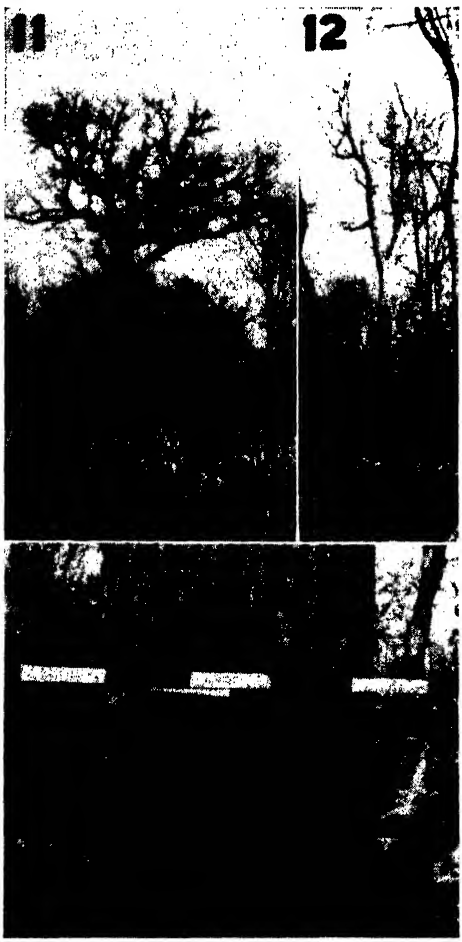


FIG. 11. An Osage county oak. *Quercus* sp. On W. R. Cook farm, southeast of Osage City, Kan. Photo by Charles Allegre.

FIG. 12. An Osage county cottonwood. On Harry Smith farm, five miles southeast of Osage City, Kan. Photo by authors.

FIG. 13. An Osage county cottonwood. Photo by Charles Allegre.

FIG. 14. The Dr. J. A. Moore cypress. A bald Cypress. *Taxodium distichum* L. Near the corner of seventh avenue and Union street, Emporia, Kan. From west. Photo by authors.

FIG. 15. The same from east. Photo by authors.

THE DR. J. A. MOORE CYPRESS

When Mrs. Ida Moore Irwin was a little girl she helped her father, Dr. J. A. Moore, plant three small cypress trees at their home on Union street in Emporia, Kan. Mrs. Irwin is still living and possesses a vivid recollection of the instance mentioned. Her father had purchased these trees from the still existing firm of Elwanger and Berry. When planted in 1870, the trees were three years old.

One of these trees is still alive and is a fine, hardy tree. This is different from what might be expected, when we consider that the Bald Cypress is quite customarily found growing in southern latitudes and often standing in water. When in water it forms large buttresses near the base and sends up "knees," presumably to secure air for its roots. Here in a dry climate it still has some of its buttressed base but no "knees" are produced.

The Moore cypress is a beautiful tree. It is rather closely hedged in by buildings, but it seems to thrive anyway. The circumference about one foot from the ground is 11 feet, 4 inches. Breast high it is 7 feet, 8½ inches. It is a large tree, as these figures show. The accompanying photographs show its attractive shape and trueness to type. (Figs. 14 and 15.)

"THE MOST BEAUTIFUL COTTONWOOD IN KANSAS"

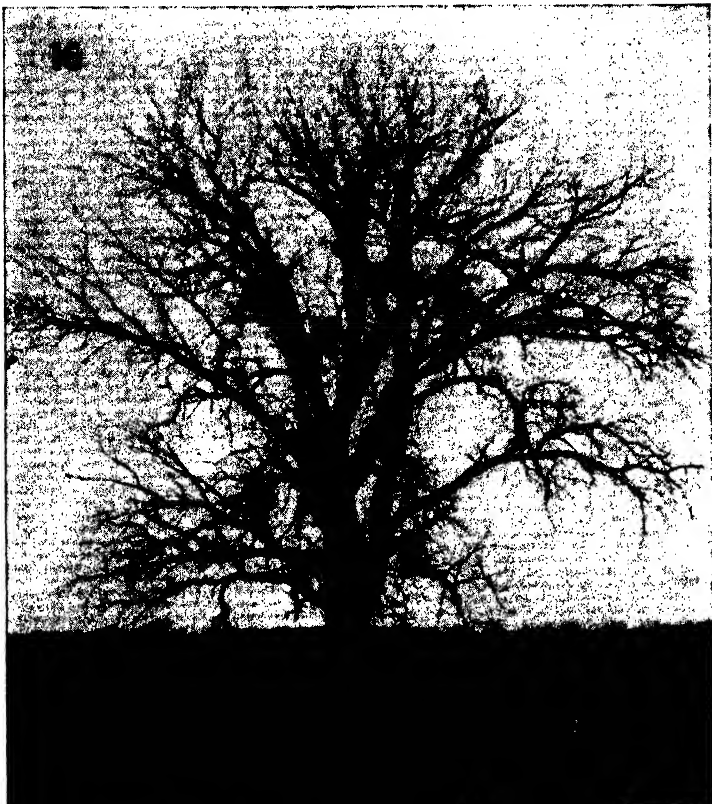
The authority for our title is no less than our revered Prof. William Chase Stevens, for many years head of the department of botany in the University of Kansas, and a member of the Academy for 46 years.

In the fall of 1868, Mr. Elwood Chapman became owner of a tract of raw prairie land about two miles east of Emporia, Kan. Some small cottonwood trees, "not as tall as a man," were growing in a swale on the claim. One of these has reached the age of "three score years and ten" and well deserves the sobriquet, "The Most Beautiful Cottonwood in Kansas."

After the death of Mr. Chapman the property passed into the hands of his son-in-law, Mr. W. T. Walters, who is still living in Siloam Springs, Ark. The story of the tree was given us by Mrs. Ella Walters Black, daughter of Mr. Walters. The land on which the tree stands is now the property of Mrs. J. E. Sparks.

Judging from its form, this cottonwood has had plenty of room for normal development. The soil and the water conditions have evidently been favorable, too. It is a large tree. Its height is something more than 95 feet. Its true girth is about 17 feet. The circle marked by its disappearing roots is more than 57 feet. The extreme width of the top is fully 108 feet. Its true diameter is over 5 feet. The cut, showing the entire tree, is from a picture made from highway 50S, from which it can be plainly viewed. Its symmetry will deceive one, as it does not appear to be the giant it is in reality. When standing close to it, it is, at least, impressive in size.

May its future years be many. (Figs. 16 and 17.)



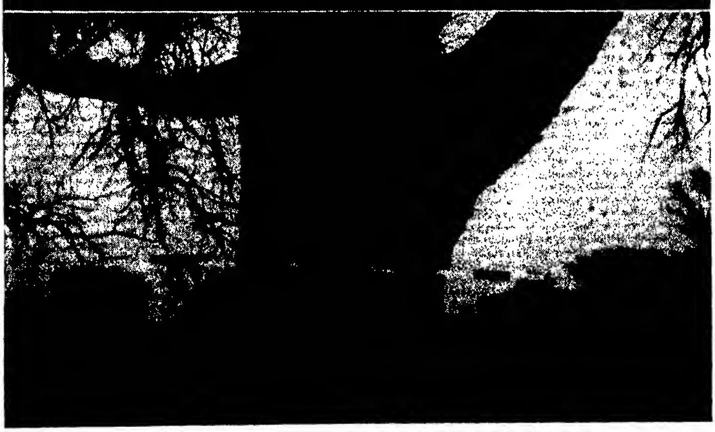


FIG. 16. The most beautiful cottonwood in Kansas. *Populus virginiana.* On Mrs. J. E. Sparks' farm, two miles east of Emporia, north side of Highway 50S. Authors.

FIG. 17. From west. Sparks home in background. Photo by authors.

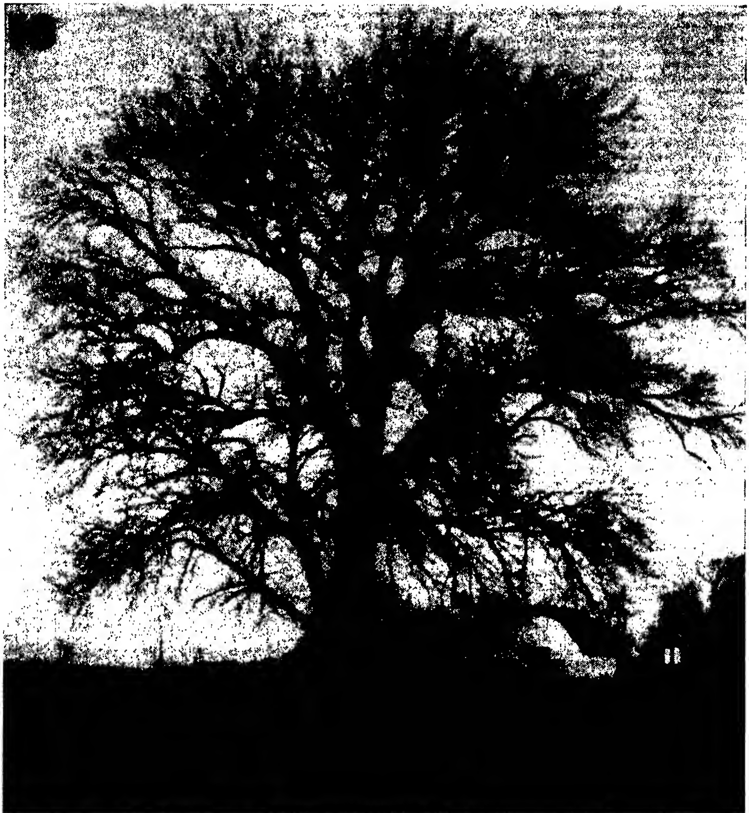


FIG. 18. A magnificent white elm. *Ulmus americana* L. On farm owned by Doctor Shelley, of Elmdale, Kan. Tree is about two blocks south of highway 50S, and near Lyon-Chase county line. Photo by authors.

FIG. 19. A magnificent white elm. From south. Photo by authors.

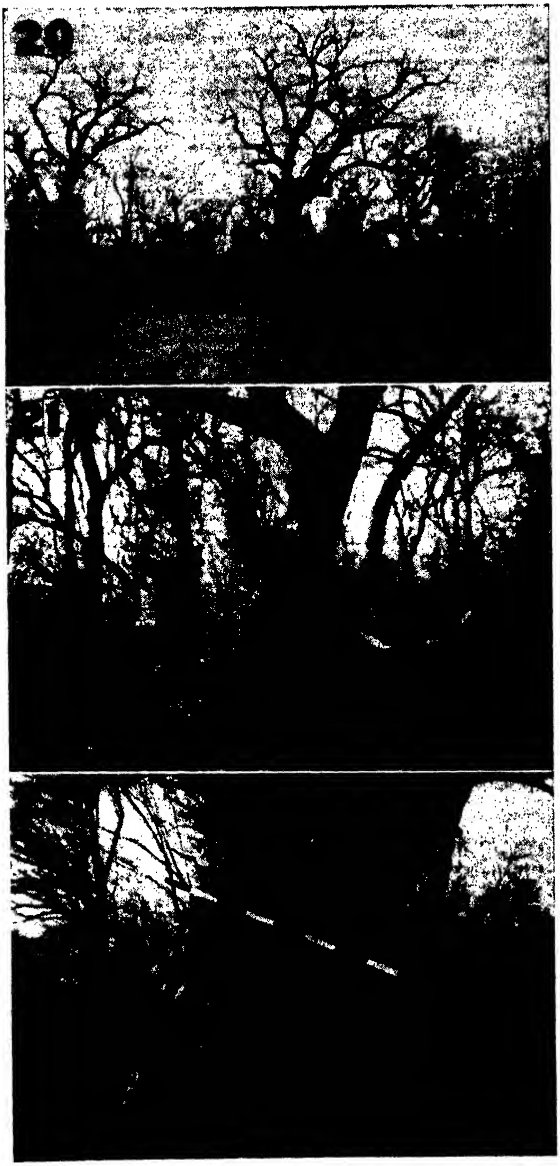


FIG. 20. A grizzly giant. *Populus virginiana*. On the farm of Mrs. B. F. Timmerman, two miles southeast of Emporia, Kan. From west.

FIG. 21. From south.

FIG. 22. From south. Photos by authors.

A MAGNIFICENT WHITE ELM

If one wishes to see a tree in its true form, he should see one that has grown in the open, where it has been able to grow naturally. Such a white elm tree can be seen a few hundred yards south of the intersection of highway 50S with the Lyon-Chase county line in Kansas. It lies just within the Lyon county boundary.

This specimen of the great American elm stands in a field of rich alluvial soil. It evidences its favorable surroundings by its unsurpassed beauty, evidence of vigor, and by its impressive size. As previously mentioned in this article, a tree that is symmetrical in form deceives one as to its size, especially if large. The trunk of this elm is 17 feet, 5 inches in circumference. One of the figures shows its diameter quite plainly. The extreme spread of its top is 98 feet. The other figure shows its beautiful form and proportions. We venture the assertion that this county-line elm has no equal in general qualifications in the state. We welcome proof to the contrary. Again we say, "May it live out its natural life and add its large part in beautifying the life of Kansas." (Figs. 18 and 19.)

A GRIZZLY GIANT

The botanist would call this tree *Populus virginiana*. Ordinary folk call it a cottonwood. A boy would probably say that it is mighty big. In fact, it is the largest cottonwood that has come to our notice in preparing these articles. It is not very tall, but it is 20 feet, 1½ inches in true circumference. As one of the pictures shows, it is nearly 7 feet in diameter.

We are calling it "grizzly" because of its rather forbidding appearance. It is evidently quite old, as shown by its great size, seemingly slow growth, and rather sad lack of thrift.

Investigation would point to some of its history. In company with other nearby trees, it leans eastward toward the Cottonwood river, which is a few rods away. When younger, it probably stood on the bank of the stream and leaned outward. Possibly, too, in times of floods quantities of driftwood lodged against it and assisted in causing it to lean. In time it could no longer return to an upright form and is still much inclined.

Several decades past, the so-called "Howard branch" of the Santa Fé was constructed and a bridge, with the accompanying embankments, forced the channel of the stream to take an eastward course north of our tree, and now the river is several rods east of it.

It is located on the farm of Mrs. B. F. Timmerman and is about two miles southeast of Emporia, Kan., in alluvial soil and a never-failing supply of moisture. It shows some serious scars, and has been mistreated, but it has persisted to an age probably greater than the "three score years and ten" allotted human life. No doubt many stirring scenes have been witnessed by it. The cottonwood is a "whispering" tree, but this one has not violated many confidences thus far.

Visit this old citizen and commune with it. Mayhap it will lay aside its reserve and unbosom to you. Do not wait too long to do this or the opportunity may pass. Figuratively speaking, it is about on its last legs. (Figs. 20, 21 and 22.)

BURYING PLACE ELMS (*14*)

When, in 1869, Mr. W. R. Soden purchased the land later known as "Soden's Grove" there were standing on it the trees shown in the accompanying cut. It was a matter of common belief that some Indians had pulled some branches of these elm trees together and placed there some of their dead. A daughter, Hallie Soden, believes that these trees were still standing in 1910. She also thinks that one of the main portions of one of the pair had become damaged and that the remaining parts were cut down.

The grove was used for chautauqua gatherings, fourth of July picnics, and other assemblages, and thousands of people saw these trees. The matter of the trees was the purported subject of an article in Ridpath's Universal History, and the accompanying picture is from a page accredited to that publication. (Fig. 23.)

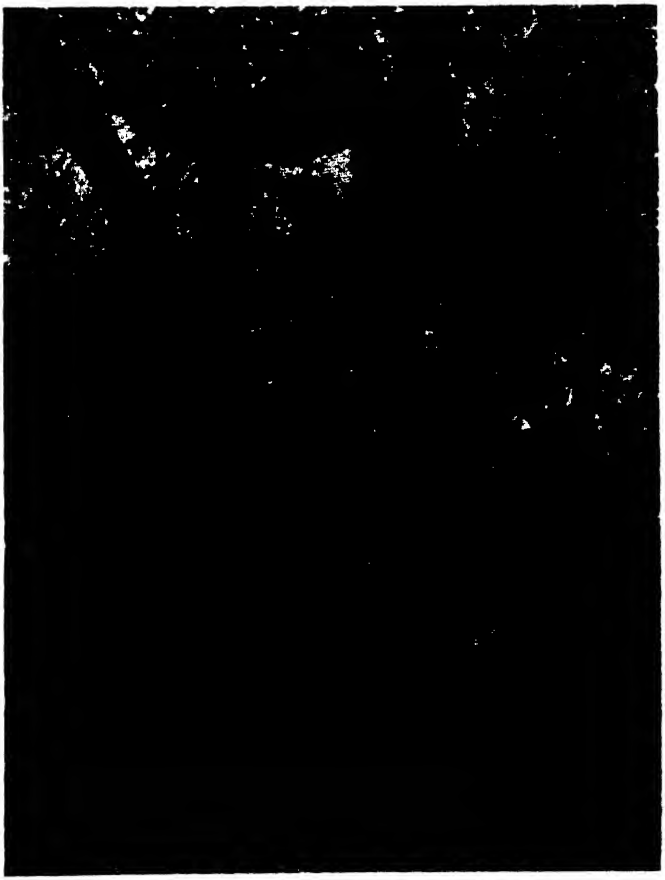


Fig. 23. Burying place elms. White elms. *Ulmus americana* L. Were in "Soden's Grove," Emporia, Kan. Ridpath's Universal History.

SOME HERON TREES[2]

For obvious reasons, we are not locating these trees with exactness. Needless to say, they are in an unfrequented region, as these birds will not tolerate much human attention. These birds are Great Blue Herons (*Ardea herodias herodias Linn.*).

Fig. 24. A heron tree. Sycamore (*Platanus occidentalis* L.) with several heron nests. Picture plane inclined. Photo by Allen Downs.

There are three groups of trees containing nests. These are some distance apart on the same stream. As the photograph shows, these birds have chosen a sycamore tree in this instance. But it is interesting to note that this is

2. Lostutter, J. W. The Heron Trees, Emporia, Kan., 1936. Downs, Allen. The Heron Trees, Emporia, Kan., 1936. Student, Kansas State Teachers College of Emporia.

the only species of tree selected in this large colony. One observer says that herons are awkward and of uncertain balance when perching. On a windy day they wobble about for a time and occasionally fall and have to make a new landing. This observer believes that the sycamore branches sway less in a wind and may be chosen partially for this reason.

A citizen, much interested in bird life, has known and visited this heronry for at least 12 years. There were twelve nests at his first visit. There are now 46. All nests are located only in the tallest trees, according to this authority. He also is certain that this place has been used by the birds for at least 38 years. (Fig. 24.)

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An Atypical or Staghorn Branch on the Wild Sumac (Rhus glabra, L.)

EMIL O. DEERE, Bethany College, Lindsborg, Kan.

In February, 1936, the biology class at Bethany College made an excursion to Twin Mounds, in McPherson county, about 13 miles southeast of Lindsborg. Near the base, on the west side of the north mound, a member of the

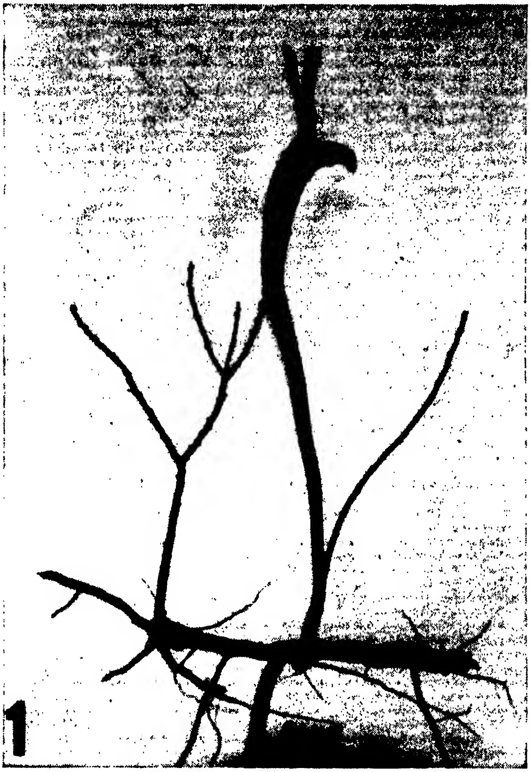


FIG. 1. Fasciated branch of sumac (*Rhus glabra*). Photo by E. O. Deere.

class called the writer's attention to a peculiar branch on one of the sumacs growing at that place. The shrub was one of several hundred growing in residual soil near the edge of a small gully about one hundred feet from the forest trees along the east bank of Gypsum creek.

As illustrated in the accompanying photograph (Fig. 1) the branch in question had grown more rapidly than the other branches of the same apparent age. Its base was of normal cylindrical form, but above this it gradually became broader and thinner, and the upper one third assumed a curved form

Trans. Kansas Acad. Sci. 39, 1936.

which caused it to resemble a much-flattened gooseneck. The branch was 65 cm. high, 1.5 cm. in diameter at the base, 5 cm. wide and 3 to 4 mm. thick near the upper end, where secondary branching occurred. Like other parts of the sumac, this branch was well supplied with buds, and each of these terminated a long and prominent ridge. This gave the branch a peculiar corrugated or fluted appearance. Two of the four terminal branches were recurved and stunted, while the remaining two were erect and larger. It was this growth arrangement which caused the branch to take on a flattened gooseneck or stag-horn appearance. The branch was well supplied throughout with healthy buds, and the tips of the secondary branches were especially well furnished with clusters of supernumerary buds.

Similar plant fasciations have been observed quite frequently in Desmodium, Cockscomb and the Ash, but we find no previous record of this type of structure in the sumac. The cause of the peculiar growth could not be ascertained, since we found no injury nor indication of attack by fungi or insects.

Kansas Botanical Notes, 1935[1]

FRANK C. GATES, Kansas State College, Manhattan, Kan.

During the fall of 1936 leaves of several deciduous trees remained on long after severe killing frosts. This was due to the fact that a vigorous late growth had accompanied good rains after the extraordinarily hot dry summer. The frosts killed the leaves while green. Leaves of cherry trees were still on in the middle of November, and leaves of *Acer saccharinum* were on until Christmastime.

On the campus of Kansas State College the two seasons' drought has taken a heavy toll of trees. According to the records of Prof. L. R. Quinlan, of the Department of Horticulture, 250 trees died in 1935, leaving 3,753 trees on the campus. This number of deaths is by far the largest ever known in one year. The heavy mortality was in part due to weakening by the drought during 1934, further abetted by that in 1935, and partly due to the destructive activities of worms and borers. The thinning caused by taking out these trees is very pronounced, as many of them were good-sized and quite conspicuous on the campus. Of the deciduous trees, the soft maple and American elm had the highest mortality rate. The American basswood and pin oaks show severe injury. Among conifers, Norway spruce, jack pine and Scotch pine had the highest mortality rate, while Douglas fir, white pine and white fir were severely injured.

The cool, dry spring of 1935 kept tulips, cherries, pears and Chaenomeles in flower for a much longer time than has ever been noted before, in extreme cases for three weeks instead of the normally few days. There was less frost injury, due to the extreme dryness. The seed crop of spring trees was very heavy in the case of *Ulmus fulva,* fair in *Ulmus americana,* and poor in *Acer saccharinum.* The accumulated dryness considerably retarded leafing out and general growth during April and much of May.

Fall flowers, particularly *Liatris punctata,* were extraordinarily abundant.

A fine fasciation in *Monolepis nuttalliana* was sent in from St. John, Kan., by Emma Maupin, in May.

Important collections made during the year included collections in central and northern Kansas in May, by the author, while accompanying J. M. Aikman and John Hubbard on their shelter-belt investigations in Kansas, and during the autumn an extensive survey of seven out of nine townships of Geary county. Other collections include miscellaneous specimens from Donald R. Cornelius which add about 40 new county records. It was the first collection for the state herbarium of *Astragalus flexuosus* and the first collection of *Andropogon ternarius* in the state of Kansas. This collection was made in Wilson county. About 100 specimens from Cheyenne county were sent in by Mrs. John M. Steller, and they made a few additional county records. A Sedgwick county collection by Sister M. Aquinas added materially to the Sedgwick county representation in the state herbarium. Donald A. Wilbur

Trans. Kansas Acad. Sci. 39, 1936.

1. Contribution No. 855, Department of Botany, Kansas State College.

collected grasses during the course of insect surveys of the state. These added over 130 county records for various grasses. These specimens were added to the state herbarium.

At Junction City, Travis Brooks found *Veronica polita* in a parking. This proved to be a new plant, not only for Kansas, but also for the United States.

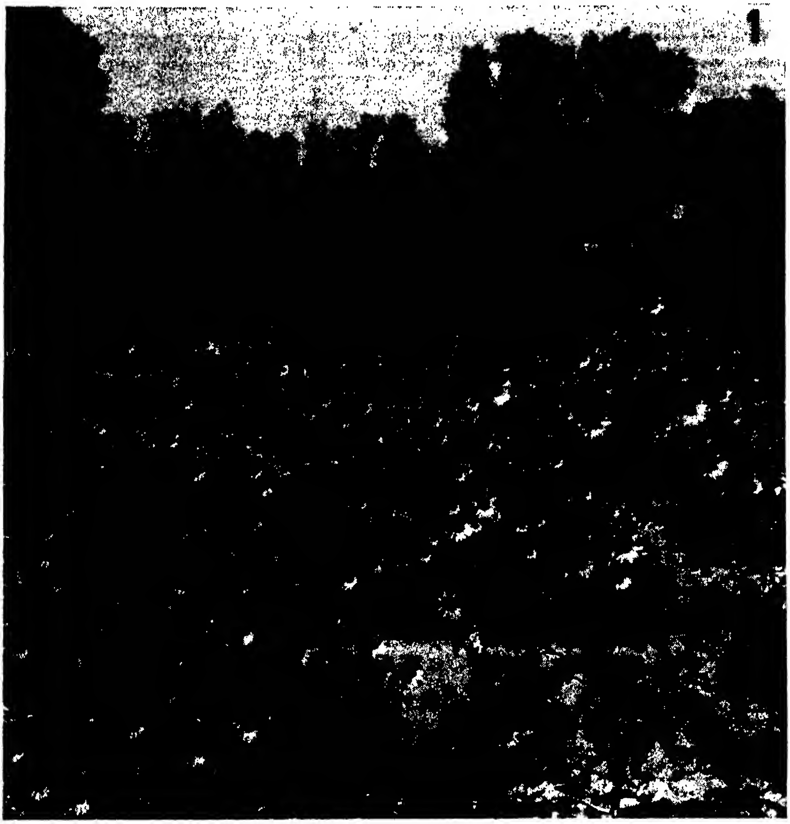


FIG. 1. A field of sunflowers near Manhattan, Kan., September, 1934. Photo by F. J. Hanna.

Herbarium specimens of Baptisia and Senecio were lent to the Missouri Botanical Garden for monographic work. The balance of the herbarium at Kansas University was checked over and the herbarium at the Sacred Heart Junior College at Wichita gone over.

The specimens of Carex have been returned from F. J. Hermann, who finds that about 40 species of Carex are represented in the state herbarium. Possibly there may be added to this five or six species credited in recent floras to Kansas, of which, however, specimens are not available. Work on the herbarium by a student employed by the National Youth Administration has been continued. This has maintained the state herbarium up to date.

The check list of ferns and flowering plants of Kansas is now in first draft and it is expected to be completed next year. Work for the grass bulletin is esentially complete.

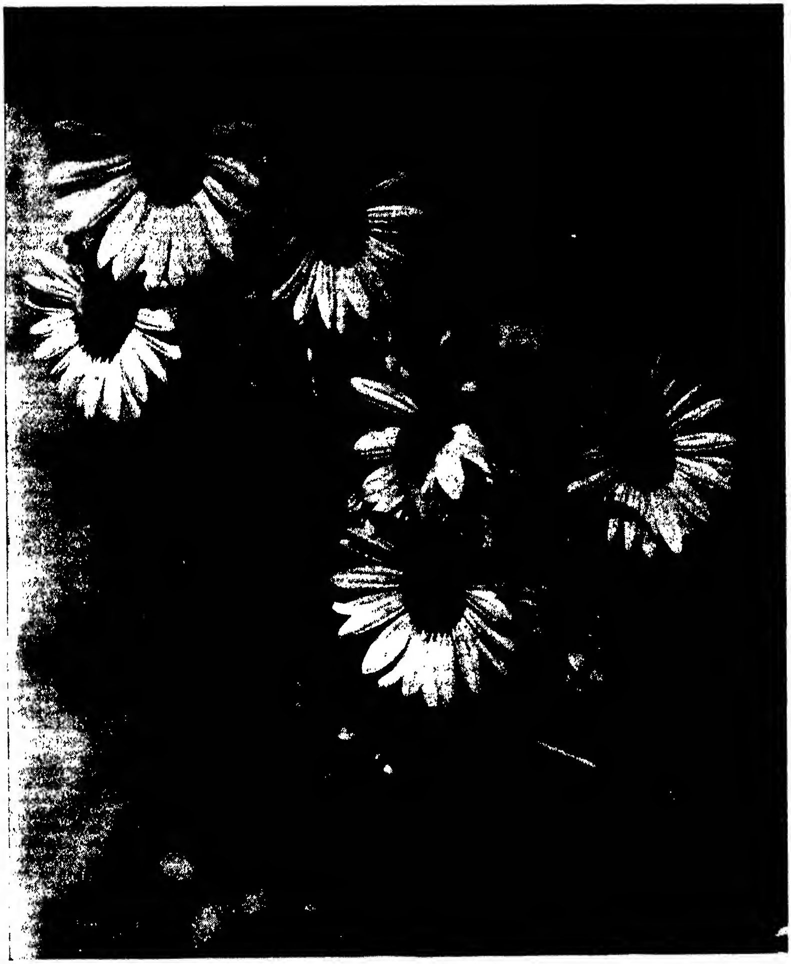


Fig. 2. A close-up of a sunflower spray, September, 1934. Photo by F. J. Hanna.

Good pictures of sunflowers are seldom seen, consequently, when sunflowers were so abundant, special effort was made to get some. The accompanying cuts are the results of the work of Mr. F. J. Hanna of the Illustrations Department of Kansas State College. (Figs. 1 and 2.)

A Preserve Unhampered by Man[1]

FRANK C. GATES, Kansas State College, Manhattan, Kan.

In the spring of 1922 the area was a cornfield southeast of Manhattan. During that summer a paving company set a sand-sucking machine, after scraping off the overburden. Their operations continued through 1923, at the end of which a somewhat C-shaped depression, with a pool of water, remained. The greatest depth of the water was forty feet. Such a depth suggested fish, and a group of anglers organized and acquired the place as Sand Lake Preserve (fig. 1). The lake was stocked with fish and a strong fence built around the whole preserve.

The land between the lake and the fence did not much interest the fishermen and nature was allowed to take her course. The accompanying pictures illustrate the vegetable development which took place. It is not the purpose of this paper to go into many details of these developments but merely to call attention to a few of the events.

The area presents several habitats, some of which merit consideration here. Near the water a crop of weeds came to cover the sandy ground during 1923. Among these weeds were many seedlings of Populus and Salix which competed vigorously with each other for dominance. On the wetter sand the willow won, but farther back, the cottonwoods did better and shaded out the willows. Floods came and wiped out both in the lowest part. The series started over again (figs. 4, 5, 6). This has happened 3 times in 14 years.

On ground just above these ordinary flood levels cottonwoods quickly shaded out the willows and the best grew into good trees, some of which are now 40 feet high and 30 cm. DBH. They do much to give the preserve the pleasing aspect it now presents (figs. 4, 6, 7).

On steep slopes of the north side several prairie grasses secured a foothold which they maintained against erosion until the shade from the cottonwoods, rooted down-slope from them, began to thin the prairie. Erosion completed the elimination of this prairie (figs. 2, 3).

On an upland knoll a host of cottonwoods took command and made a dense forest of thin-stemmed trees. When these were about 3m high, a wholesale natural thinning took place, commencing in the center. The thousand-odd trees thinned down to less than a hundred. These in turn competed too severely and are now reduced to eight (figs. 8, 9, 10, 11).

Desultory cultivation was allowed in small parts of the preserve. This has allowed weeds to dominate those parts even to the present.

A comparison might be made with a similar area two miles away, where grazing, fire, and general human activities have brought none of the pleasing appearance of the preserve—weeds, year after year, no trees nor shrubs.

A perusal of the figures accompanying will impress one with the effects of protection alone. It shows how well nature itself can make a beauty spot if unhampered by man.

Trans. Kansas Acad. Sci. 39, 1936.

1. Contribution No. 360. Department of Botany.

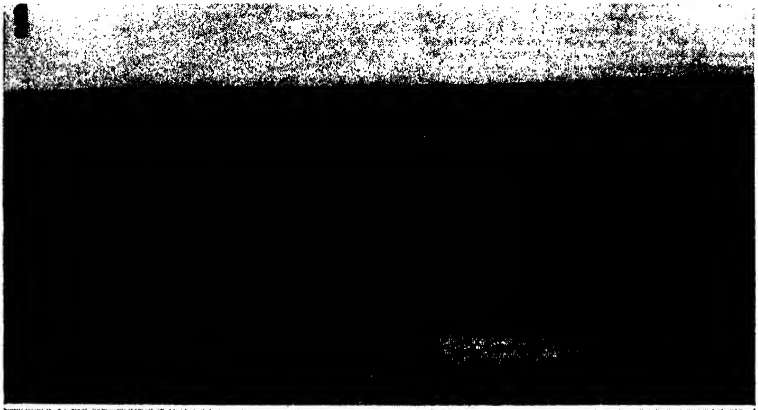


FIG. 1. General view from adjacent bluffs of the Sand Lake Reservation before fencing. The cottonwoods in the foreground on the east bank of the Kansas river. October, 1924.

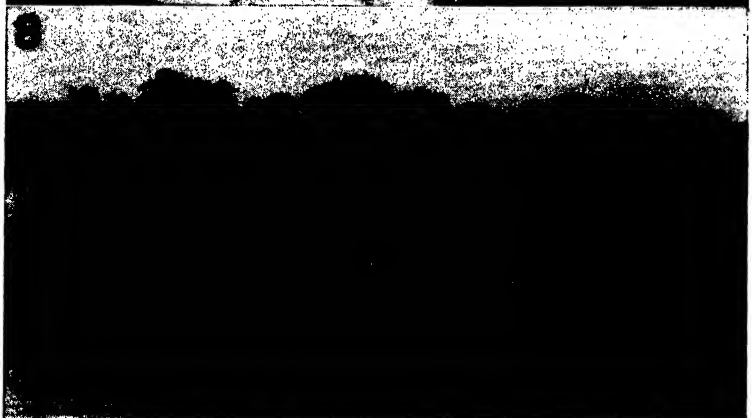
FIG. 2. The north bluff, showing steep bank with willows and cottonwoods beginning near the water's edge. September, 1924. (Confer with 3 and 4.)

FIG. 3. The north bluff, now largely obscured by cottonwoods. Crescent Spit in the foreground, with dead willows and cottonwoods after a long high water. September, 1929.

FIG. 4. Looking eastward across Sand Lake Reservation. May, 1932.

FIG. 5. From the high north bank, southward over Crescent Spit and Crescent Island, before the reserve was fenced. Part of a cornfield in the background. October, 1924.

FIG. 6. View from the same place as figure 5. September, 1934.



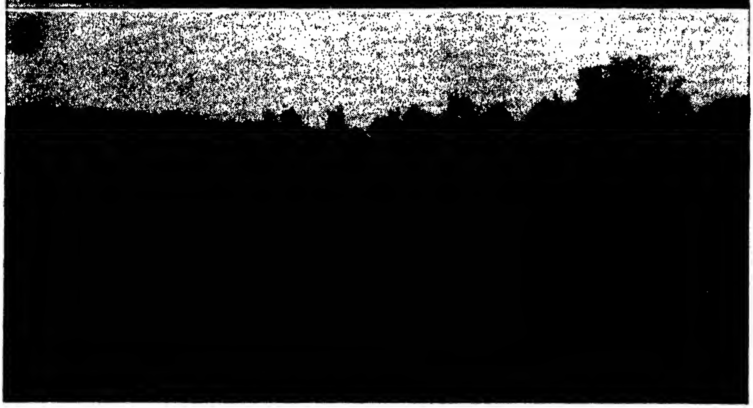


FIG. 7. Crescent bayou, following a summer of very high water. Cattails and arrowheads which formerly occupied all of the space now killed by high water. September, 1932.

FIG. 8. Looking westward to the middle part of the region before fencing. Note peninsula covered with grass. October, 1924.

FIG. 9. View of the same area as figure 8, from the north, after the cottonwoods had covered the peninsula so thickly as to kill many by competition. November, 1929.

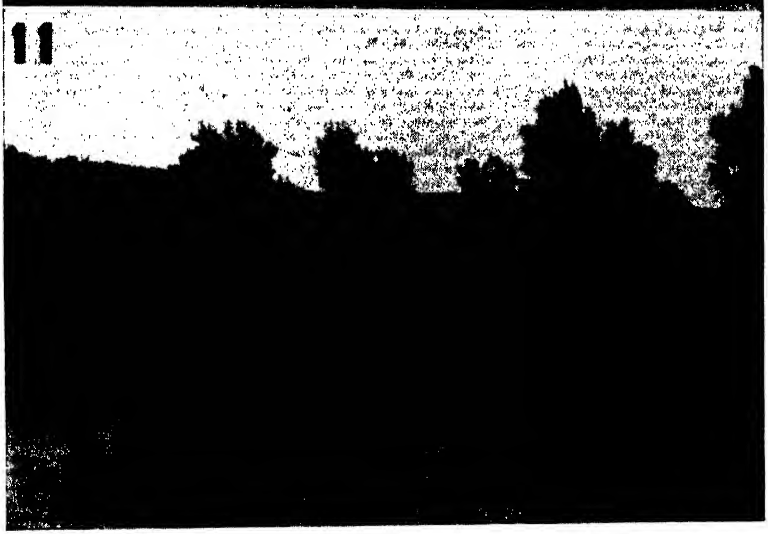


FIG. 10. View of the peninsular region, looking across Crescent Spit. Note the cottonwoods only on the perifery of the central peninsula, and a heavy weedy growth on Crescent Spit, in the foreground. October, 1933.

FIG. 11. Southeastward to the central peninsula three months after the big flood. Compare with figures 8, 9, and 10. September, 1935.

Kansas Mycological Notes, 1935[1]

C. L. LEFEBVRE, Kansas State College, and C. O. JOHNSTON, U. S. Department of Agriculture, Manhattan, Kan.

The weather conditions that prevailed in Kansas during the winter and early spring of 1935 undoubtedly were largely responsible for certain unusual mycological occurrences. The winter was mild and extremely dry, and very severe dust storms occurred from February to May. Severe drought persisted until the middle of May, after which heavy rains fell over much of the state at intervals of a few days for a period of more than a month. Rainfall during June was very heavy, and severe floods occurred in all of the principal river valleys. Although the temperature during this rainy period was subnormal and tended to lengthen the vegetative period of plants, it was not low enough to interfere with the germination and development of parasitic fungi. Conditions, therefore, were nearly ideal in most parts of the state for the rapid development of many diseases of plants.

Perhaps the most important mycological event of 1935 was the disastrous epidemic of stem rust of wheat that swept the western Mississippi Valley and Great Plains area during June and July. Kansas was directly in the pathway of the scourge (which started in central Texas and gained in intensity as it moved northward) and suffered the greatest losses from that source since the epidemic of 1916 and possibly since the devastating one of 1904.

The epidemic of 1935 apparently was brought about by a succession of favorable factors occurring in proper sequence over the vast wheat-growing area from central Texas to the prairie provinces of Canada. These factors were as follows:

1. Abundant overwintering of stem rust in central Texas and the development of heavy local infections during early May.
2. Heavy rains in late May and early June, which delayed heading and prolonged the fruiting period of the very susceptible Mediterranean type wheats in north-central Texas.
3. Moisture and temperature conditions favoring the rapid multiplication of rust in north-central Texas. This factor, combined with delayed maturity, resulted in the development of a heavy epidemic in that area and furnished a vast amount of inoculum for distribution farther north by prevailing southerly winds.
4. Delayed heading of the Kansas crop caused by the early spring drought, which lasted until mid-May.
5. Greatly lengthened vegetative and fruiting period of winter wheat in Kansas due to heavy rains during June.
6. Moisture and temperature conditions favoring rapid propagation of stem rust in nearly all parts of Kansas during June and July.

The proper combination of all of these factors resulted in a tremendously heavy infection of stem rust on wheat in all parts of Kansas. Infection was very late in its appearance, due to early spring drought, but developed to epidemic proportions during the last two weeks of June. Stem rust moved into

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Trans. Kansas Acad. Sci. 39, 1936.

1. Contribution No. 356, Department of Botany, Kansas State College.

southern Kansas the last week in May but was not observed at Manhattan until June 5.

Several unusual features that are worthy of note accompanied the 1935 epidemic. Although much of the wheat in the western third of the state was destroyed by the winter and early spring drought, occasional fields survived and produced a crop of plants that were thin in stand, short in stature, and late in maturity. Reports were received that such plants frequently were noted to be heavily infected with stem rust, even though they never had fully recovered from drought injury.

Another unusual circumstance was the heavy development of stem rust on late tillers of drought-injured winter wheat in central Kansas. In that area many fields seemed to be nearly destroyed by drought, but the plants put out a few heads about the middle of May. After the heavy rains began such plants often developed many new tillers from which developed a crop of heads in late June. These tillers were still grass-green when heavy stem rust developed in late June and early July. Many fields that gave promise of a fair crop from late-tillers were utterly destroyed during early July.

One of the heaviest blows of the 1935 epidemic was dealt to winter wheat on fallow land in northwestern Kansas in early July. In that section wheat on fallow gave promise of an excellent crop until July 1, but much of it was very severely injured by stem rust during the succeeding ten days. Much of it was so badly damaged that the farmers scarcely harvested as much grain as they had sown.

The loss caused by stem rust in 1935 has been estimated at 12 percent, or about 7,000,000 bushels, for the entire state of Kansas. In certain localities the loss was much higher than 12 percent and the loss in the eastern half and northwestern section of the state undoubtedly was considerably above that figure. The estimate is based only on actual reductions in yield and loss in grade but other types of loss were definitely noted. There was evidence of the following four distinct types of losses due to stem rust:

1. Actual reduction in yield per acre.
2. Loss in grade due to shriveling. Most of the wheat harvested in Kansas in 1935 was badly shriveled and in many cases had test weights as low as 45 pounds per bushel.
3. Reduction due to abandonment of badly rusted fields that would otherwise have been harvested.
4. Loss in succeeding crop due to poor germination and weak plants produced by shriveled grain used for seed.

Leaf rust infection was favored by the same factors as those favoring the development of stem rust and a heavy infection developed in most parts of the state. The epidemic was very late in its initiation and did not reach its maximum development until about June 25. Within a few days after that date leaf rust in many fields was masked by the more spectacular stem rust infection.

BLACKCHAFF, GLUME BLOTCH, AND LEAF BLOTCH OF WHEAT

The heavy rains of late May and June resulted in rank vegetative growth of wheat in many parts of the state. This was particularly true of an area in south-central Kansas. In that area the frequent heavy rains and rank growth of the wheat crop favored heavy infections of blackchaff (*Bacterium*

translucens undulosum) and glume blotch (*Septoria nodorum*), which resulted in considerable damage. The occurrence of both of these diseases in quantities to cause severe damage is unusual in Kansas. Blackchaff can be found in small amounts in some localities nearly every year, but glume blotch in anything like epiphytotic form over a considerable area is a very unusual occurrence. An area including parts of Harper, Sumner, Cowley, Sedgwick, and Harvey counties was affected by these diseases in 1935.

Leaf blotch (*Septoria tritici*) was generally distributed throughout the state but was noted to be very severe in drought-injured fields of the central and southwestern parts. Even where stands were thin and plants short in stature. and where drought conditions persisted until harvest, this disease was prevalent. By June 25 the plants in many fields were so heavily infected that many leaves were prematurely withered and dried and others had their active green surface seriously reduced. In experimental plots at Manhattan many promising early hybrid lines, such as selections from the Prelude × Kanred and Kanred × Hard Federation crosses were very heavily infected. Standard varieties of hard red winter wheat were only moderately infected and the few varieties of soft red winter wheat tested were only lightly infected.

Several other diseases of wheat were noted in Kansas in 1935, but their importance was overshadowed by the severe rust epidemic. Bunt (*Tilletia laevis*) probably was considerably less prevalent than usual, owing to the reduction of the wheat acreage in the western part of the state by drought. Loose smut (*Ustilago tritici*), which has seemed to be increasing in amount during recent years, was present in about the same amount as in 1934. Flag smut (*Urocystis tritici*) continues to persist in traces in Harvest Queen wheat grown along the Missouri river in Leavenworth county, but does not seem to have increased in distribution, prevalence, or severity during the period it has been under observation in this state. Basal glume rot (*Bacterium atrofaciens*) was observed in traces in many fields in the eastern third of the state, but in no case was it observed to be severe enough to cause measurable damage.

The unusual weather conditions of the spring of 1935 also favored the development of heavy local epidemics of stem rust and crown rust of oats. These diseases were very late in their development and were severe only in the eastern third of the state. At Manhattan, infections of both diseases were extremely heavy by July 1, and their combined attack resulted in severe lodging and rapid deterioration of what had given promise of being a bumper crop of oats.

Halo blight (*Bacterium coronafacieus* Elliott) and the bacterial blade blight (*Bacterium striaefaciens* Elliott) were very common on oats grown in experimental plots at Manhattan. In the more susceptible oat varieties, such as Canadian, Swedish Select, and Green Russian, the head was often prevented from emerging from the boot resulting in sterility when the halo blight infection occurred on the sheaths of the upper leaf.

Although the summer of 1935 was very dry and unfavorable for sorghums in nearly all parts of Kansas, there was a fair crop in some localities. In certain localities of the western part of the state, kernel smut (*Sphacelotheca sorghi*) infection was very high. Some large commercial fields had as many as 25 percent of the heads smutted, and infections of 10 to 15 percent of the plants were fairly common.

A most unusual type of infection produced by *Sphacelotheca sorghi* was observed in experimental plots at Manhattan. Sorghum panicles that were thought to be infected with head smut (*Sorosporium reilianum*) were collected and examined. Most of the individual spikelets in these panicles were entirely missing and the panicles reduced to a few branches that were much twisted and distorted and the surfaces of which were entirely covered with large smut sori. In some cases even the panicle branches had been completely destroyed by the fungus and only the central rachis remained. This was often distorted and usually completely covered with smut sori. The fungus, therefore, produced large sori on glumes, panicle branches, rachis, and occasionally even on the peduncles below the heads, and was assumed to be head smut. Microscopic examination of the spores, however, revealed them to be characteristic of *Sphacelotheca sorghi* in size, shape, color and general appearance.

The late blight of potato caused by *Phytophthora infestans* (Mont.) de By. was found in several fields of potatoes near Oakland, Kan. Although the late blight fungus has been mentioned previously in several reports of the Kansas Agricultural Experiment Station, this is believed to be the first time that it actually has been seen and collected in the state. The fungus is not included in the late Dr. Elam Bartholomew's Fungus Flora of Kansas, nor was there in our herbarium a specimen of this organism collected in Kansas.

It probably should be mentioned that Prof. W. T. Swingle, in describing the Kansas Peronosporaceae at the twenty-first annual meeting of the Kansas Academy of Science (1887-'88), vol. XI, November 1, 1889, page 64, stated that he was including a description of the "extra limital genus Phytophthora, as it is very probable that it will soon be known in the state." On page 69 of the report he wrote: "This species, the cause of 'potato rot,' has not, to my knowledge, been collected within the limits of Kansas by any mycologist." He further stated that in the annual report of the Department of Agriculture for 1888, a map showing the distribution of the "potato rot" in the southern and northern portions of Kansas can be found. "It also gives the potato crop as injured to the extent of 0.7 percent by the rot. It is, therefore, very probable that this species occurs in the state."

The seed planted in the fields at Oakland, Kan., came from Maine, and the seed tubers must therefore have been diseased before they arrived. This is an excellent illustration of how a pathogenic organism might be introduced into areas where it had never before been found. The cool moist weather during the latter part of June and early July made conditions ideal for the development of the disease, but as favorable weather did not continue, very little if any damage to the potato stand occurred.

In contrast to the rather apparent limited distribution of the downy mildew of potato, several downy mildews of noncultivated plants were very common. For example, wherever *Sophia intermedia* Rybd. was found, *Peronospora parasitica* (P.) Fr. could be observed in long, linear, white pustules, causing the affected parts of the plants to become swollen. *P. parasitica* on *Lepidium densiflorum* Schrad., *P. effusa* (Grev.) Rabh. on *Chenopodium album* L., *P. oxybaphi* Ell. & Kell. with numerous oöspores in leaves of *Oxybaphus nyctagineus* (Michx.) Sweet, *P. trifoliorum* on alfalfa, *P. arthuri* Farlow producing abundant oöspores in leaves of *Gauara paviflora* Dougl. and *Plasmopora geranii* (Peck) Berl. & De Toni on *Geranium carolinianum* L. were collected and seemed to be very common in the eastern part of the state.

Appreciation of the importance of grasses in the general scheme of agricultural development in the state has increased greatly during the past few years, and as a result their diseases received particular attention. As no facilities were available for traveling and collecting over the state, a special effort was made to interest several of the men in the Division of Forage Crops and Diseases in submitting diseased specimens.[2]

From this source, numerous specimens of ergot (*Claviceps purpurea*) on various grasses were received from many points in the eastern half of the state. Some of the grasses parasitized by the ergot organism were *Andropogon furcatus, A. scoparius, Phalaris arundinacea, Elymus virginicus, E. robustus, E. canadensis, Koeleria cristata, Sorghastrum nutans, Agropyron pauciflorum, A. smithii,* and *Poa pratensis.* It was reported that in one 80-acre field with almost a solid stand of western wheat grass (*A. smithii*) in southeastern Kansas, about 75 percent of the heads were affected with ergot. In another case a Kansas seed company sent to the State Seed Testing Laboratory at Manhattan a sample of bluegrass seed that contained three percent by weight of ergot. This bluegrass seed was reported to have come from Iowa.

Bacterial blight of brome grass caused by *Bacterium coronafaciens atropurpureum* Reddy & Godkin was found to be prevalent on *Bromus inermis, B. japonicus,* and *B. tectorum,* in north central Kansas, while *Dactylis glomerata* was attacked to a lesser degree. The disease was first evident during the latter part of May, and with the favorable moist weather which then ensued, it developed rapidly so that by June 20 the upper portions of the culms, just below the panicle, were discolored, the color ranging from a greenish-brown to almost black. This discoloration extended up onto the rachis and pedicels of the panicle, and in such severe cases, seed failed to form in many florets, resulting in a high degree of sterility. The symptoms on the four grass species are very similar to those of blackchaff of wheat, suggesting the possibility of a very close relationship between the blackchaff organism and the one causing the disease on wild grasses.

Several smuts of wild grasses were collected in the vicinity of Manhattan, while others were sent in from various other localities in the state. *Ustilago striaeformis* (Westd.) Niessl. and *Urocystis agropyri* (Preuss) Schrot, were collected on *Elymus virginicus* L. for the first time in Kansas. *Sphacelotheca sorghi* (Lk.) Clinton on Johnson grass (*Sorghum halepense* (L.) Pers.) also was collected in the state for the first time. Another interesting grass smut *Ustilago bromivora* (Tul.) Fisch. v. Waldh. occurred commonly on *Bromus japonicus* Thumb. around Manhattan. This smut seems to be widely distributed and may possibly become of economic importance. It has only recently been reported as causing considerable damage to slender wheat grass (*Agropyron pauciflorum* (Schwein.) Hitchc. in Alberta (*3*) where this grass is extensively grown for hay.

Several collections were made of a smut on *Bouteloua gracilis* (H. B. K.) Lag., which appear to be more closely related to *Ustilago boutelouae* Kell. & Sw. than to any of the other smuts that occur on this grass. A collection of *Ustilago buchloes* Ell. & Tracy on *Buchloe dactyloides* (Nutt.) Engelm. was received from western Kansas.

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2. The writers wish to thank Messrs. D. Cornelius, L. Jacobson, and G. O. Mott for kindly sending diseased specimens.

Collections of *Sorosporium ellisii* Wint. on both little and big bluestem grasses were received from many localities in the eastern half of the state. This is interesting fungus because the sori are frequently mistaken for ergot unless examined closely. Before the smut sori break open and spores are distributed, the whitish-gray sori are very conspicuous as they are sometimes 3 cm. or more in length. Another smut, *Ustilago ischaemi* Fckl., was collected in two localities in the state on little bluestem. The life histories and cultural characteristics of several smuts on the bluestem grasses are now being investigated by Mr. Earl D. Hansing, a graduate student in the Department of Botany, Kansas State College.

Cerebella andropogonis Ces., another unusual and interesting fungus occurring on grasses, was collected in Kansas on both the little and big bluestems in 1935. Specimens of this fungus were also sent to us by Mr. G. O. Mott from Texas, where it was colected not only on these two grasses, but also on *Andropogon hallii* Hack, and *Sorghastrum nutans* (L) Nash.

Cerebella andropogonis Ces. usually has been considered nonparasitic but has often been placed in the Ustilaginales. After germinating the spores and studying the fungus in detail, however, the writers believe it should be placed in the Moniliales of the Fungi Imperfecti as indicated by Clements and Shear (*1*). The black, soft, convolute fruiting bodies are very conspicuous in the inflorescences of the grasses mentioned. The nuriform spores germinate readily in water and produce abundant mycelium from which conidia are abstricted.

Whether or not this fungus is parasitic is questionable, though it was noticeable that affected florets did not produce seeds. If this fungus should prove to be parasitic, it could be spread readily during the collecting and threshing of the various grass seeds, since the spores are loose and are borne in great numbers.

Two other grass-infecting fungi that are rather uncommon in Kansas were collected during the past summer (1935). These were *Epichloe typhina* Tul., found on *Bouteloua gracilis* and *Koeleria cristata,* and *Dothichloe atramentosa* Atk., found on *Andropogon scoparius* Michx. The latter fungus never had been reported as occurring in Kansas previous to this collection. Both of the organisms prevented the inflorescence from emerging, hence causing sterility.

Dr. H. Fellows reported western wheat grass (*Agropyron smithii*) affected with foot-rot (*Ophiobolus graminis*) in several localities in the vicinity of Milford, Kan. The disease strikingly manifested itself by causing the affected plants to produce many "white heads."

One interesting occurrence of an entomogenous fungus recently came to the writers' attention. Mr. E. T. Jones, of the United States Bureau of Entomology, located at Manhattan, sent pea aphids that had been attacked by *Empusa* sp. The insects were being propagated for experimental purposes on potted alfalfa plants grown in a cold frame. The sudden outbreak of the disease caused almost total loss of his aphid culture.

Although the fungus causing the leaf spotting of honey locust (*Gleditsia triacanthos*) has often been collected in Kansas, it might be well to mention finding it again as Miller and Wolf (*2*) have made a thorough study of the causal organism and changed its taxonomic position. The fungus (*Linospora gleditsiae*) causing the spotting of honey locust was found in both its conidial and perithecial stages.

In the mycological notes of 1934, it was mentioned that *Gymnosporangium globosum* produced many pycnia but very few aecia on Crataegus leaves. It was believed the lack of aecia was due to the extreme drought of 1934. During the spring months of 1935 the weather conditions were more favorable because of heavy rains that undoubtedly aided in the mixing of the pycnial exudate. This resulted in the later development of the aecial lesions on the Crataegus leaves. A large number of affected leaves were collected, and the pycnial and aecial lesions were counted. It was found that about 33 percent of the lesions produced aecia. This is in sharp contrast with the observations of the drought year 1934 when only about 10 percent of the lesions produced aecia.

Following is a list of fungi that have been found in Kansas on new hosts, and those marked with an asterisk appear to be reported from the state for the first time.

* *Cerebella andropogonis* Ces. on *Andropogon scoparius* Michx., *A. furcatus* Muhl., *A. halli* Hack., and *Sorghastrum nutans* (L.) Nash.

* *Cyathus vernicosus* (Bull.) DC. on decaying herbaceous stem.

* *Dothichloe atramentosa* Atk. on *Andropogon scoparius* Michx.[3]

Fusarium graminum Cda. on ergot in florets of *Andropogon furcatus* Muhl.[4]

* *Fusarium semitectum* Brk. and Rav. on florets of *Andropogon furcatus* Muhl.[4]

* *Glonium parvulum* (Ger.) Cooke. on elm log.

* *Leptothryrium dryinum* Sacc. on *Quercus imbricaria* Michx.

Phyllachora graminis (P. ex Fr.) Fckl. on *Sporobolus neglectus* Nash.

* *Phytophthora infestans* (Mont.) de Bary on *Solanum tuberosum* L.

Puccinia graminis Pers. on *Bromus japonicus* Thumb.

Scolecotrichum graminis Fekl. on *Dactylis glomerata* L.

* *Septoria bromi* Sacc. on *Bromus inermis* Leyss.

Sphacelotheca sorghi (Lk.) Clinton on *Sorghum halepense* (L.) Pers.

Urocystis agropyri (Preuss) Schrot. on *Elymus virginicus* L.

* *Ustilago bromivora* (Tul.) Fisch. v. Wald. on *Bromus japonicus* Thumb.

Ustilago straieformis (Westd.) Niessl. on *Elymus virginicus* L.

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3. Identified by Dr. W. W. Diehl.
4. Identified by Dr. C. D. Sherbakoff.

A Note on the Canker Disease of Gardenias

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Recently some Gardenia plants were brought into the laboratory from a local greenhouse, bearing rough swollen cankers on the stem bases. Isolations were made from the infected tissues and a species of Phomopsis was readily obtained in pure culture.

A similar canker disease of Gardenias has been reported occurring in greenhouses in California by Hansen and Scott (*1*) and in Ohio by Tilford (*2*) in 1934. The latter had not maintained a culture of his fungus, but a culture was received from Doctor Hansen with which to compare the organism isolated here.

In the greenhouse referred to above, three varieties of Gardenias were grown: Californiae, Belmont and Veitchii. Of these three the Californiae was by far the most susceptible, all the plants of this variety succumbing to the disease. The Belmont was next, with seven casualties to date, representing about 10 percent of the plants of this variety. None of the variety Veitchii have been killed, although a dozen or so plants out of 72 have cankers at the present time and are still under observation.

Symptoms of this disease manifest themselves indirectly in the leaves and flowers while the stems are directly attacked by the fungus. These symptoms are:

1. *Leaves.* The leaves tend to change in color from dark to pale green and then yellow before dying and becoming dried and brown. Many of the leaves fall after turning yellow.
2. *Flowers.* Several infected plants were observed to shed their flower buds before they opened. This feature was observed on some normal plants but was particularly noticeable on infected plants.
3. *Stem.* At the base of the stem typical cankers are produced. These lesions are first seen as sunken greenish brown spots which soon encircle the entire stem. This is followed by a hyperplasia in the cortex of the infected area and then these tissues crack, giving a rough corrugated appearance to the canker.

Although the Phomopsis isolated by Hansen and Scott is apparently a new species, these authors have not yet described it. While only a few observations have been made to date by way of comparing the form isolated in Kansas with the culture obtained from Doctor Hansen, there is nevertheless reason to believe the two forms may be distinct morphologic strains if not distinct species. Growing on potato dextrose agar the organism isolated here has floccose mycelium which tends to form concentric circles with pycnidia frequently being formed at the margins of the circles. The pycnidia are fairly large and the spores for the most part are elliptical ovoid with occasional spores that are fusiform in shape. The California fungus on the other hand has little mycelial growth, pycnidia are very numerous but much smaller and many of the spores are spherical in shape.

Furthermore, Hansen and Scott reported that their fungus infected several varieties and appeared to be exclusively a wound parasite. The observations

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made here gave rather definite evidence of varietal susceptibility with all of one variety, the Californiae, only seven Belmonts and no Veitchii being killed to date. The California Phomopsis was reported as frequently producing cankers on branches and stems at a distance from the soil. With but one exception all cankers on the plants observed here were at the crowns. In one plant a canker was observed which originated at a node in the stem some four inches above the soil level.

Painting the stems of healthy plants with Semesan at intervals of 10-14 days appears to have been effective in checking the spread of the fungus. However, observations covering a longer period of time along with the use of control plants are needed before definite control recommendations can be made.

Sufficient to say, if this disease breaks out in other greenhouses as it has here it could cause significant losses and be a deterrent factor in the greenhouse propagation of gardenias.

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Distribution of Seeds by Dust Storms

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I. INTRODUCTION

The menace of the dust storms in western Kansas, eastern Colorado, western Oklahoma and northwest Texas, during the winter of 1934 and the spring of 1935, is well known. The writer had the opportunity to see much of this territory during June, 1935, while assisting with a detailed ecological survey of native pastures made by the federal government under the direction of D. A. Savage, of the Division of Forage Crops and Disease, Bureau of Plant Industry, United States Department of Agriculture. The damage to the native vegetation by soil blowing, intense heat and severe drought ranged from very little to almost complete destruction. The top soil was removed from many fields, leaving barren subsoil showing the marks of past cultivation. Native vegetation was injured most severely when overgrazed and lying adjacent to blowing fields. Scarification by wind was probably responsible for much of the killing. In some places this action was so severe that the crowns of grass were entirely exposed or removed. In other places, where old vegetation was present in quantities, the smothering effect of wind-deposited soil was undoubtedly an important damaging factor.

In pastures where scarification did not take place, one inch or less of fine dust was deposited throughout the affected area. From observations made since the dust storms, the thin layers of fine silt have not proved harmful, except that they retarded the absorption and percolation of moisture. In many cases the thin or tight soils may have been improved in potential fertility by the addition of fine, loose material. Another benefit was the formation of an excellent mulch cover for the seedlings, much needed to replace the grass killed by the drought.

It is the popular belief that numerous weed seeds were deposited with the dust, and that these were gathered at points where the storm originated and carried to remote locations; or at least some distance from where the dust was picked up by the wind.

The objects of this investigation were to determine the amount and kind of seeds carried by the dust storms and how they were transported. This was accomplished by collecting samples of the dust deposited in various places and under various conditions, and germinating the seeds found in a unit volume.

II. TYPES OF SOIL

The soils around Hays, Kan., have been formed from limestones, sandstones, and shales, and have been mapped under several different names, including the Colby series (*1*), Western residual soils (*2*), Cretaceous chalk and shale soil province (*3*). As remapped by C. F. Marbut (*4*), the soil around Hays is known as "Hays," while the soil of northwest Trego county and southwest Graham county is known as "Holdrege." The surface soils of this series are

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dark gray or dark brownish-gray. The upper subsoil is usually slightly lighter in color, heavier in texture, more compact in structure, and ranges from two to eight inches in thickness. The members of this series are composed largely of loessial deposits, and have been in their present position for comparatively long periods.

According to Middleton, Slater and Byers (*1*), three to six inches of the original surface soil have been lost by erosion since the fields in this area have been put under cultivation. These soils are more erosive on the surface than many of the other darker soils, and are therefore quite susceptible to wind erosion. The remainder of the upper stratum is, however, much less erosive.

The dust or wind-blown materials used to represent sandy areas were taken from south of Great Bend and north of Greensburg, Kan. The sandy soils have also been mapped under several different names. They were originally designated as "Pratt," but later changed to "Hays" by Marbut (*4*). Both water and wind erosion are particularly destructive to sandy soils, which are not underlayed with a firm subsoil as are the soils of the Colby series. Chemical analyses (*1*) show the sandy soils to be about 90 percent SiO_2, and the Colby series about 68 percent. The soils of the Colby series contain considerable more organic matter than do the sandy soils. In short, the Colby series contains less sand and more of other compounds than the sandy soils.

Microscopic and chemical examinations reveal that the materials carried in the air are primarily SiO_2, having the fineness of silt, with very little clay. The materials carried along the ground vary according to the origin and to the total distance moved. Samples taken from buildings and from pastures where surface movement was at a minimum were composed of very fine sand and silt. The drifts near fields are primarily small granules of soil intermingled with an extra supply of sand. The granules may be compared to small clods of the same composition as the soil of the fields from which they came.

Microscopic measurements showed the air-blown particles to range from .07 mm. to .006 mm. in diameter, with an average of about .038 mm. The material carried along the surface ranges in diameters between .8 mm. and .001 mm., averaging about .08 mm., but when wet or ground, many of these are reduced to a diameter of about .0005 mm.

The sandy soils are much more easily broken up than the darker soils; thus, when blowing takes place, these soils are soon reduced to loose sand. The materials deposited from the air in a sandy area are similar to those originating from darker soils. These results were obtained from burning and acid treatment of both the heavy and sandy soils. About 90 percent of the original material remains after treatment with acid and burning, showing that most of the wind-blown materials moved in the air are inorganic. The same results were obtained on treating the dust collected in buildings.

III. MOVEMENT OF SOIL

The soil moves in the direction of the wind, being deposited in and around the first obstacle that breaks the force of the wind. In this respect, weeds, grass, fence rows and artificial windbreaks serve as lodging places for the moving soil. If no such windbreaks are present, as where the adjacent pasture land has been grazed to the ground, the moving particles will be carried along the surface to the nearest topographic barrier. Small canyons and draws often

catch much of the moving soil. The next windy day the soil will be again moved unless the wind is from the same general direction, which is usually not the case. Drifts may be shifted several times without the soil actually moving very far. This is not the case with the very fine materials that get into the air. In this case the heavier sand particles are deposited first, and the lighter materials are probably carried several hundred miles from where the storm originated and probably are brought to earth with rain.

The actual amount of dust carried in the air is indicated by the following data. After a severe duststorm 388.5 grams of dust were collected from a square foot of surface in front of windows on the third floor of the Science Hall at Hays. On the floors of the observatory a square foot yielded 133.5 grams, and the same space in the center of a large fairly tight room, after several dust storms, yielded 91.5 grams. According to these figures, dust was deposited at the rate of 8,768 pounds (4.334 tons) per acre in the center of the large room, and at the rate of 14,993 pounds (7.413 tons) per acre, on the floor of the observatory.

Numerous measurements were made to determine the thickness of the dust deposited on pasture land. These were made at locations in the pastures where the surface movement was at a minimum. The average thickness was about three fourths of an inch, or approximately 172,497 pounds (86.248 tons) per acre. These figures should not be taken as absolute for any given area, as the variations are great, but from many observations it is believed that a fair average has been reached. With the coming of the spring rains, much of this deposited soil was removed from the slopes, while that on the level was usually held in place, thus becoming a part of the soil.

IV. COLLECTION OF SAMPLES FOR GERMINATION

Samples of dust for germination studies were collected from the agricultural area around Hays, Kan., and north about twelve miles to the Saline river. Samples were also collected in buildings on the campus, and from houses, garages, and sheds in the city of Hays. Samples were taken from sticks projecting from ponds, where as much as five inches of blow-dust collected. (No germination of seeds was obtained from these samples.) The same general type of soil was sampled from similar locations northwest of Ellis in Trego county, and into the edge of Graham county. A few samples were obtained from pastures and fields just south of Great Bend, Kan., and others from the sandy soil area north of Greensburg in Kiowa and Edwards counties.

Samples were obtained under as many conditions and as close together as possible. This was done to eliminate such variables as types of soil and moisture content.

With these points in mind, samples of surface-blown material were taken from drifts close to blowing fields, and from pastures under several variations in grazing intensity. Factors such as distance from blowing fields, amount of grass, and condition of adjacent blowing fields, were considered. Other samples were taken in places where the dust could not have been carried in by rolling along the surface. It was impossible to locate directly comparable areas in all cases, but those selected were considered sufficiently comparable to warrant drawing of fairly definite conclusions.

V. GERMINATION

The seeds carried in the dust were germinated in a greenhouse during the winter. Short six-inch pots were filled within approximately two inches of the tops with soil and sand which had been sterilized by heating for several hours in a gas-heated oven at about 300° F. This destroyed the viability of all the seeds except those introduced with the samples. The samples were measured in a graduated cylinder, using 200 cc. for each sample which weighed 200 grams on the average. Each sample was spread over the surface of the sterile soil, giving a depth of about one inch.

The pots were placed in the greenhouse, where bottom heat was applied. An extra amount of light was furnished by placing a 200-watt bulb over the pots, extending the length of day about four hours. Water was added with a fine spray, to avoid injuring the seedlings. This was not always possible, as under artificial conditions many of the seedlings were quite weak. Some of the plants died before they were large enough to identify.

The plants were identified as soon as possible, and removed from the pots to allow room for more plants to grow. In all cases it was possible to identify and remove plants soon enough to keep down overcrowding.

It is probable that many more seeds were present, at least in some cases, than were actually germinated. It is a well-known fact that many seeds will not germinate except under favorable conditions, and some are very slow in germinating (*5*). In some cases rather spasmodic germination was observed, In others, some plants (probably Oxalis) would come through the soil, but the second pair of leaves would never open. From observations made during the growing season, seeds of lamb's-quarters (Chenopodium) were probably present, but if they were they failed to germinate. Fifty-eight samples were tested. The results of the tests of a few representative samples are shown in the following tables (1 to 3).

INTERPRETATION OF RESULTS

Samples Taken from the Hays Area

Very few seeds germinated in the samples taken from such places as pastures where no surface blowing took place, and no germination was obtained from those taken from buildings. Six samples from nonsurface-blown pastures north of Hays gave no seedlings, three taken from the large college pasture germinated two plants. Several samples taken from buildings gave no growth. It is quite evident that seeds were not carried to any great extent in the air in this area, though as previously shown, the air did carry rather enormous amounts of soil materials.

The soils of the cultivated fields in this area are of the transported type, classified as Colby silty clay loam (*1*). Samples taken from blown materials that had been moved along the surface produced many seedlings (table 1). This shows that seeds may be blown for some distance in this manner. Several samples of this type indicate that seeds may become more numerous per unit volume of the blown material where it has been carried along the surface for some distance. This is probably due to the breaking up of the soil and the removal of much of the lighter materials, thus allowing the seeds to be drifted over the surface.

TABLE I.—Number and kinds of seedlings found in representative samples of wind-deposited, loessial type soils from the agricultural section and in the city of Hays, Kan.

Species.	Drifts and checks north of Hays.				Drifts near town.			Drifts in town.		
	*Near blown field, grass weeds.	Check from soil.	†One half mile in over-grazed pasture.	Check from old sod.	Near field on all sides.	Grass strip, field on all sides.	Highway ditch, field on one side.	Back porch, ground level.	Open garage.	Street of Hays.
Pig weed (*Amaranthus* sp.)	39	2	136	1	24	5	12	3	9	3
Fire weed (*Kochia scoparia*)	...	...	...	...	...	...	...	...	2	5
Russian thistle (*Salsola pestifer*)	9	...	3	...	...	...	...	...	...	...
Spurge (*Euphorbia* spp.)	3	...	...	...	3	1	2	...	...	...
Unidentified dicotyledons	3	...	...	...	2	...	4	1	...	...
Stink grass (*Eragrostis cilianensis*)	50	...	80	...	45	20	4	5	3	3
Foxtail grass (*Setaria viridis*)	30	3	48	...	...	...	3	2	...	...
Witch grass (*Panicum capillare*)	16	...	...	...	15	5	...	...	...	...
Drop-seed (*Sporobolus cryptandrus*)	8	...	15	1	12	...	...	...	...	...
Unidentified grasses	6	...	29	...	9	11	2	4	...	2
Total plants	164	5	311	2	110	42	31	15	14	13

Scattered clumps of we allowi uent movement of the soil as wind changed.
Few small clumps of gı allow uent changing of the small drifts.

TABLE 2.—Number and kinds of seedlings found in representative samples of the wind-deposited soil collected from the tight-soils area northwest of Ellis, Kansas, in Trego and Graham counties

Species.	Drifts.			Pastures, no surface blow.	Buildings.	
	Fifty yards in small pasture, blown on all sides.	One half mile in overgrazed pasture, blown on two sides.	High drift in small pasture, blown on two sides.	Total of three samples.	Rather open shed.	Attic of house.
Pigweed (*Amaranthus* sp.)	9	15	3	3	1	
Russian thistle (*Salsola pestifer*)	2					
Shepherd's purse (*Capsella bursa-pastoris*)	2	5				
Ragweed (*Ambrosia psilostachya*)	1					
Purslane (*Portulaca oleracea*)	3	3				
Plantain (*Plantago purshii*)		5				
Buffalo bur (*Solanum rostratum*)	2					
Spurge (*Euphorbia* spp.)	3					
Unidentified dicotyledons	5	8	4			
Stink grass (*Eragrostis cilianensis*)	31	16	21	2	1	
Foxtail grass (*Setaria viridis*)	1					
Witch grass (*Panicum capillare*)	6		2			
Wild crabgrass (*Schedonnardus paniculatus*)	3	3				
Unidentified grasses	2			1		
Total plants	92	44	36	6	2	0

Samples From Northwest of Ellis in Trego and Graham Counties

The soils of this area are primarily of the residual soil type, are comparatively tight and contain only small amounts of sand. A large number of species germinated in the samples taken from this area (table 2), though the total number of plants germinated was less than from samples collected under comparable conditions around Hays. The samples from the moderately grazed pastures show some growth probably due to the shortness of the grass which would allow some surface movement. The samples taken from buildings where the seeds could enter only by being carried in the air gave no growth.

Samples from the Sand Area

The soil just south of Great Bend is very sandy, while the soil north of Greensburg is sandy but moderately tight. No samples were obtained from buildings in this area. The samples taken from pastures where no surface blowing took place produced only one plant in six samples. The drifts gave some growth (table 3) though few as compared to the dark soils. The number of germinations were less in the samples taken from the very sandy area than those taken from the tight sandy soil area.

Observations made throughout the sandy areas after the spring rains (June, 1935) showed few seeds per unit area, which is in agreement with these results. Less germination was obtained from the sandy soil area than from the darker soil area under similar conditions. This may be explained by the difference in the size of soil particles and the manner in which the soil is moved. Comparatively little of the sandy soil is carried in the air nor does much of the soil leave the immediate vicinity. Thus a pile of blown material was found to be of almost the same composition as the soils of the adjacent fields.

TABLE 3.—Number and kinds of seedlings found in representative samples of wind-deposited soil collected from sandy areas south of Great Bend and north of Greensburg, Kan., during the severe dust storms of the spring of 1935

SPECIES.	Surface movement.*						Pastures, no surface blowing.†	
	Great Bend.		Greensburg.					
			Fence row.					
	Drift in field.	Near field in weeds.	Blown on two sides.	Blown on one side.	Tall grass and weeds.	Over-grazed pasture one-fourth mile in.	Tall grasses.	Tall grasses and weeds.
Pigweed (*Amaranthus* sp.)	2	2	.....	2	3	5	1	.....
Russian thistle (*Salsola pestifer*)	.....	.....	4	2	.....	.....	.....	.....
Ragweed (*Ambrosia psilostachya*)	.....	.....	3	.....	.....	.....	.....	.....
Unidentified dicotyledons	.....	.....	.....	.....	4	3	.....	.....
Foxtail grass (*Setaria viridis*)	.....	2	3	.....	3	3	.....	.....
Unidentified grasses	3	3	2	3	8	2	.....	.....
Total plants	5	7	12	7	18	13	1	0

* Drifts formed by surface movement.
† Pastures with enough vegetation to stop all surface movements.

SUMMARY

1. No growth was obtained from numerous samples taken from buildings.
2. Usually no seeds germinated in the samples taken in large moderately grazed pastures, where surface blowing was at a minimum.
3. Fewer seeds germinated per unit volume from the sandy soil area than from the darker soil area. (56 contrasted with 357 seeds per soil sample 12x12x1 inches.)
4. Most of the seeds that germinated were of the type usually considered as weeds.
5. Small seeds may be carried from some distance over the surface where there is no vegetation to collect the moving soil.

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Nutritional Factors Influencing Vision; A Review of Literature

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Among those compounds which are of chief importance in the nourishment of the human body, deficiencies of the two vitamins A and G (B_2) stand first in their effects on vision. Lack of vitamin A causes the conditions known as xerophthalmia, which is designated by some authors as xerosis or keratomalacia, and hemeralopia, also called nyctalopia or night blindness. Lack of vitamin G (B_2), it is believed, causes certain forms of cataract.

VITAMIN A

According to McCollum (1925), the earliest reports we have of xerophthalmia as a dietary disease are found in the writings of Livingstone in 1857, in which he describes the hardships suffered during his explorations in Africa. He states that when the party was forced to live on a diet of coffee, manioc roots, and meal, their eyes became affected (as in the case of animals fed on experiment on pure glutin or starch). Although McCollum was unable to find any records of those experiments which Livingstone alluded to, it is quite remarkable that any were done at that early date.

In 1904 Mori reported on a study of upwards of 1,000 cases of xerophthalmia among the Japanese children, living inland, who were fed on a more or less vegetable diet. He noted that the disease never occurred among the seaside dwellers and that those who had it could be readily cured by eating either liver or codliver oil.

It was in the field of experimental nutrition, however, that vitamin A appeared on the scene. According to Sherman and Smith (1931) it seems that Osborne and Mendel (1913) are credited with the discovery of the relation of vitamin A deficiency diets to xerophthalmia among rats, and that the "infectious disease" could be relieved by feeding codliver oil or butter.

However, the actual recognition of xerophthalmia as a vitamin A deficiency disease among human beings must be left to McCollum and Simmonds, who four years later definitely came out and stated, "We feel confident that these cases of xerophthalmia reported by Mori and Bloch should be looked upon as a deficiency disease not hitherto recognized in its true relation to the diet. It is not . . . a fat starvation which produces the condition but a lack of the unidentified dietary factor, fat soluable A, which occurs in just those foodstuffs which they observed to possess curative properties. . . ."

This statement of McCollum and Simmonds was very well confirmed in subsequent reports of Bloch two years later (1919), when he conducted a nursing and feeding experiment upon a group of thirty-two healthy children ranging in age from one to four years. Half the group were used as controls and the other half were fed a diet deficient in vitamin A foods. Within a

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month eight cases of xerosis had developed among the group receiving the deficient diet. These were speedily cured by the administration of cod-liver oil.

The above mentioned reports—along with other work of Bloch, Blegvad, Widemark, and others, especially those concerning the children of Denmark—greatly impressed the fact of human xerophthalmia on our investigators in the western hemisphere. During the years 1909 to 1920 in Denmark, Bloch (1924) reports that the greatest number of xerophthalmia cases appeared in 1916-1917, when a great decrease of butter consumption took place and most of the butter fat was exported. The disease occurred especially among infants under one year of age who were fed almost entirely on oatmeal gruel, barley soup, and pasteurized skimmed milk. The following year when butter consumption was rationed by the Danish government, xerophthalmia practically disappeared.

Several investigators have studied the pathological changes which occur in cases of avitominosis A. Concerning those changes related directly to the eye, Bulley (1919) questioned the view of McCollum, Simmonds and Becker that xerophthalmia is a dietary disease alone and suggested that some infection must be associated with it, too. However, his contentions were disproved by the subsequent work of Emmet (1920), in which both boric acid or argerol solutions failed to relieve the conditions. Emmet's findings were confirmed by Osborne and Mendel in 1921.

From their bactero-histological studies, Stephenson and Clark (1920) concluded that avitaminosis A lessens the resistance of the cornea so that any chance bacteria in the conjunctival sac may invest the epithelium and destroy the tissues. This view was supported the following year by Wason (1921), who observed the necrosis or keratinization of the outer layer of the corneal epithelium. Wason considers the infections to be secondary to the changes caused by lack of vitamin A.

The various reports of Yudkin and his colleagues (1922) are supported by the findings of Mori (1923), who considers the changes in the lacrymal glands the chief occurrence preceding the onset of the disease. Similar views on the hyperplasia and metaplasia of the corneal epithelium are held by Tyson and Smith (1929) and Mouriquand, Rollet, and Chaix (1931).

According to the work of Hughes, Lienhardt, and Aubel (1928), incoördination and spasms result from avitaminosis A, and an histological examination of the animals in the advanced stages of the disease shows a decided degeneration of the various nerve fibers in the optic, sciatic, and femoral nerves. This report is confirmed by the more recent one of Mellanby (1934), who believes that in case of avitaminosis A, the xerophthalmia is secondary to a loss of neurotropic control, which is normally exerted by the ophthalmic fibers of the 5th cranial nerve.

The above mentioned report of Hughes *et al.* (1925) also shows that lack of vitamin A affects the eye even during embryonic development. In one particular litter of nine pigs, seven of which were born alive during the experiment, the lids were malformed, the eyes were opaque, and none of the pigs could see. "This," according to Hughes, "is a case in which eye lesions developed in fetuses apparently because of the insufficient amount of vitamin A received by the mother during the first part of the gestation period, although she received an abundance of this vitamin during the last part of her pregnancy." Similar work has just been reported by Hale (1935).

One of the early questions in the minds of the various workers was the minimum amount of vitamin A necessary for normal metabolism in infants and adults. In 1920 Hess and Unger, in their report on an experiment with five infants fed on what they assumed to be a vitamin A free diet, concluded that infants needed only traces of vitamin A, if any, in their diet in order to keep in good condition. Subsequent experiments by McCollum and his colleagues have disproved this view entirely.

Numerous other workers have published various figures on the necessary amount of vitamin A in the diet, but evidently from the recent report of the League of Nations (1935) the figures suggested by Rose (1933)—of 3,000 units, U. S. Pharmacopoeia, or 4,200 international units—are considered to represent the vitamin A needs of the average man.

As one would naturally expect, xerophthalmia is treated by supplying the missing factor to the diet of the patient. According to McCollum, in India, natives suffering from the disease apply a liver poultice directly to the eyes. The usual modern clinical methods are to supply vitamin A in the form of high vitamin A content foods, as liver, cod-liver oil, etc., or in the form of concentrated extracts either by way of the mouth or by subcutaneous injection (Blegvad, 1924). Some practitioners use carotene (precursor of vitamin A) or carotene extracts, and among certain European workers both alcoholic and water extracts of carotene have been used as washes for afflicted eyes.

Closely linked with xerophthalmia, and in fact, its forerunner, is the condition of nyctalopia, sometimes called hemeralopia or night blindness. According to McCollum it was first recognized as a dietary disease by Krienes in 1896. Reports of this condition have come from the plantation workers in Brazil to the natives of Newfoundland and Labrador—from Russia, Japan, and India—in fact, nearly every country in the world.

As in the case of xerophthalmia, night blindness was also questioned as to its being a deficiency disease as shown by the report of Appleton (1921) in his observations on deficiency diseases in Labrador. However, in 1922 a chain of experiments was started which eventually proved nyctalopia to be a nutritional condition alone and answered the age-old question as to the function of the rhodopsin or visual purple.

Ejler Holm (1922) in his studies on the decoloration of visual purple discussed the change to visual yellow and stated that the rhodopsin (visual purple) regeneration is more rapid when the retina is in contact with the pigment epithelium—and that the yellow is more stable when the pigment is detached. Fridericia and Holm (1925) studied the regeneration of rhodopsin in the eyes of rats that had been deprived of this vitamin. They showed that lack of vitamin A did not influence the amount of rhodopsin in the eyes of rats kept in the dark, but that when the pigment had been bleached by exposure to light, the regeneration of the rhodopsin in the deficient rats was much slower than in the normal ones. They also showed that no such abnormality of regeneration existed in the rats that had been deprived of vitamin B but not of vitamin A.

The importance of the above experiment was further enhanced by a later one reported by Holm (1925) in which he definitely showed that in rats, as in humans, nyctalopia develops before any signs of xerophthalmia appear. This view was confirmed by the report of Aykroyd (1930) in which he states

that after three weeks of vitamin A deprivation, severe night blindness will appear in man before there are any other signs of xerophthalmia or vitamin A deficiency.

The next step came in 1930, when Lythgoe and Tansley perfected a method of studying colored solutions, especially that of rhodopsin, by means of the optical cell and photography. Following that, Yudkin, Kriss and Smith (1931) reported from their analyses that the retinas of animals' eyes are among the richest sources of vitamin A known. The same year Miss Tansley studied the problem of regeneration of visual purple in A-deficient rats. Although her methods were greatly improved and more accurate than those of Fridericia and Holm, her results more or less confirmed those of the others.

Again in 1933 Tansley reported that the regeneration of rhodopsin apparently depends upon the normal circulation of the retina, choroid and rods, and that in vitamin A deficiency she concluded that chemical changes occur in the outer limbs of the rods and interfere with the production of visual purple. This report is more or less linked with that of Holm in 1922.

The final peak was reached in a series of experiments by George Wald (1933, 1934, 1935), in which he definitely proved that vitamin A is present in the eye tissues, and is a component part in the synthesis of rhodopsin. Wald also states that with the possible exception of hepaxanthin no other carotenoids are found in the eye tissues.

There has always been a question as to the occurrence of xerophthalmia and night blindness in the United States. According to Hess and Kirby (1933), returns from a questionnaire sent to fifty of the leading ophthalmologists throughout the country indicate that these conditions are quite rare and that there was no increase in these diseases during the economic depression. In a recent communication Doctor Kirby informs the writer that, "There may be minor degrees of avitaminosis among many of our populace, but certainly the more severe degrees are limited to few in this country."

According to the work of Jeans and Zentmire (1933), in which an instrument was perfected to detect conditions of avitaminosis A by the patient's dark adaptation ability, forty-one subjects out of a group of 213 were subnormal in their dark adaptation—a condition which was cured within twelve days by supplying a good diet, supplemented with cod-liver oil. McCollum has frequently stressed the importance of proper nutrition, and at the recent meeting of the American Medical Association, Dr. J. B. Youmans, of Nashville, Tenn., was quite emphatic about the prevalence of vitamin deficiency diseases and the necessity for the members of the profession to be able to recognize such conditions.

VITAMIN G (B_2)

In 1926, after Goldberg and his co-workers had demonstrated that water-soluble vitamin B had at least two factors, Goldberg and Lillie reported certain changes in the eyelids of rats kept on a diet low in vitamin G. The following year (1927) Chick and Roscoe, in reporting on the experimental studies on the nature of vitamin B, mentioned that rats showed a condition of alopecia of the eyelids, followed by conjunctivitis and ophthalmia. Salmon, Hays, and Guerrant (1928) reported that in addition to the conjunctivitis and alopecia of the lids, conditions of lacrimation, ptosis, and opaque eyeballs occurred in some of their rats suffering from vitamin G deficiency.

With this single reference to opaque eyeballs by the above workers, nothing of similar nature appeared until in 1931 when Day, Langston and O'Brien, working at the University of Iowa, definitely linked the condition of cataract with vitamin G deficiency. According to their results the rate of incidence varied as high as 92 percent in their experimental animals. The following year O'Brien made extensive histo-pathological studies in the eye changes of rats on vitamin G deficient diets, and concluded that they are characteristic of the changes typical in cataract.

A whole series of experiments were now performed by these various workers and more convincing results were obtained that supported the conclusions from their earlier experiments. In 1933-'34, Langston and his colleagues obtained equally good results in mice and wild rats as well as in chickens and monkeys. Day and Langston (1934) reported further evidence that nearly all of their rats receiving vitamin G deficient diets, had developed cataract, and from their observations they concluded that cataract is perhaps a better gauge of vitamin G deficiency than dermatitis.

Following these reports, which have been so favorable, we have a series of more recent ones coming from England, with results more or less contrary to those reported by our American workers. György (1935) reports that in a series of extensive experiments involving over some 500 rats, he has never observed any conditions of cataract.

Bourne and Pyke (1935) report similar observations, but they have an incidence of from 20 percent to 31 percent of cataract. Also, as opposed to Day and Langston the year before, they obtained from 73 percent to 100 percent of dermatitis in their experimental animals.

In December, 1935, Doctor Elvehjem, of the University of Wisconsin, in his review of the present status of the vitamin B complex, presented the more recent evidences that the vitamin complex is actually made up of at least four factors, B_1, B_2, B_3, and B_4, in addition to the flavins. Consequently, much future work on the purification and assay of the different factors, along with a more complete understanding of their chemical properties, will be necessary in order to clear the present situation.

SUMMARY

Experiments have shown the conditions of xerophthalmia and night blindness to be caused by lack of vitamin A in the diet. The question of the relation of vitamin A to visual purple in the retina and its cycle has been more or less completely solved, although we expect other discoveries along the same trend in the future.

Experiments have also shown that certain types of cataract may result from lack of vitamin G in the diet. Just which factor of the complex is necessary for the prevention of such eye lesions is yet unknown.

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The Lime Content of Rocks of the Upper Cretaceous System of Ellis County, Kansas [1]

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In this study an investigation was made of the lime content of the Upper Cretaceous System of Ellis county, Kansas, with reference to the percentage of lime contained in rocks of the various formations and members in respective parts of the county. Also, the attempt has been made to determine the consistency of the percentage of lime in a given member in various parts of the county, as well as of different beds of a given member in the same locality. The possibility of the existence of limestone of a percentage sufficiently high to be used for cattle feeding and for the manufacturing of lime has also been investigated.

So far as the writer has been able to learn, there has been no work done in determining the chemical composition of the rocks of the Upper Cretaceous System of Ellis county, other than, possibly, that made at Yocemento. However, the cement factory once there has been closed for many years and no printed materials are available regarding this enterprise. The geological background of the present study has been based upon the report of N. W. Bass, entitled "Geologic Investigations in Western Kansas."

The formations involved in this study are the Niobrara, the Carlile Shale, the Greenhorn Limestone, the Graneros Shale, and the Dakota Sandstone, and their members.

All of the rock samples under consideration for this problem were obtained through personal visits from surface outcroppings of the strata in various localities. Whenever possible the samples were taken from large outcroppings. Representative samples were secured from a given stratum and whenever there appeared to be a difference in rock structure in the same outcropping, samples were taken from each type of rock structure. The samples were taken from a wide range covering the greater part of the county, including the various formations and members of the Upper Cretaceous System. A geological map of Ellis county, published by the State Geological Survey, was used as a guide in helping to locate and to distinguish the various strata. However, the obtaining of the rock samples themselves was done more or less by trial and error, since the geological map showed only which stratum was nearest the surface and gave no definite indication as to where an outcropping might occur. Therefore it was necessary to drive in a car on section lines until an outcropping of a rock formation was observed. By taking careful observation of the speedometer reading of the car, as to miles covered, the exact position of the outcropping rock formation could be located, thereby confirming the formation and member from which the sample was obtained. A cold chisel and hammer were used in dislodging the rock sample from the main stratum. Care was taken that enough of the stratum was chiseled away to be assured that the

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sample obtained had not been exposed to weathering. Each sample was placed in a wide mouth jar. These in turn were labeled as to the formation, with the exact section, township, and range from which the sample had been obtained.

The laboratory procedure involved the quantitative determination of calcium, following a standard method and involving the volumetric procedure using a standardized solution of potassium permanganate as the titrating agent.

The lime content of the samples taken from the beds of the Smoky Hill chalk member do not show as great a variation as might be expected, considering that many of the beds appear to contain more shale than chalk. The high runs 52.95 percent lime and the low 39.88 percent lime, a variation of approximately 13 percent. Ten out of twelve of the samples run higher than 45 percent lime, which indicates that this member runs fairly high in lime content.

The Fort Hays limestone member shows less variation among its samples in percent of lime content than the Smoky Hill chalk member. The difference between the high and low is but approximately 6 percent, and eight out of ten samples run from 50.85 percent to 54.26 percent lime. The Fort Hays limestone member not only averages the highest in lime content, but the percentage of lime in its beds throughout the county is also quite constant.

The Blue Hill shale member seems to be consistent in its lack of lime, running less than half a percent in two runs taken from widely separate localities in the county.

The Fairport chalky shale member of the Carlile shale shows the widest variation in lime content among its samples of all the members, with a high of 51.21 percent and a low of 26.87 percent. It might be interesting to state here the result of the findings in sec. 9, T. 15 S., R. 20 W., in the Fairport member. From a large outcropping of shale the sample runs 26.87 percent; from the same locality but from a chalk bed a few feet lower the sample runs 46.17 percent, a variation of approximately 20 percent.

Five of the six samples taken from the Greenhorn limestone formation run quite constant in percentage of lime, the difference in range lying between 51.67 percent and 52.35 percent. Sample 34, however, drops approximately 11 percent below the others. Sample 33, taken from the same location, but from a chalk bed, runs 51.76 percent. The indications are that the Greenhorn formation runs fairly constant in percentage of lime, excluding the thin beds of shale.

The Graneros shale formation, which is primarily composed of sandstone beds, runs surprisingly high in lime. The samples taken from the narrow strip of Graneros shale exposed in Ellis county runs 49.88 percent lime.

The sample taken from the Dakota Sandstone formation contains 43 percent lime, which is a relatively high lime content for sandstone beds.

It might be well to mention some of the interesting economic possibilities that Ellis county offers relative to this problem. Probably one of the most important economic uses of limestone is its use in the production of Portland cement. The necessary raw materials for the production of Portland cement are lime in the form of limestone and clay or shale. The latter must contain silica, iron oxide, and alumina. These raw materials, in the form of limestone

and shales, are found abundantly in the Upper Cretaceous formation of Ellis county.

Lime, more properly called quicklime, is the oxide of calcium, CaO, and is obtained by driving the carbon dioxide out of limestone. Limestone suitable for the production of lime should contain not less than 50 percent of lime. As the tables in this study show, many limestone beds of this region are suitable for lime production.

Lime, as quicklime, is used for mortar, with a mixture of lime, sand, and water. Mortar has been largely displaced by Portland cement, but seven tenths of the lime made is still used for structural purposes, and in industries, such as ammonia soda, gas purification, paper making, and tanning. Hydrated lime is used to make sand bricks, and as a fertilizer; it is also one of the raw materials for bleaching powder.

Lately much attention has been given to the possibility of using ground limestone in cattle-fattening rations, especially in this section of the country in which legume hays are not grown. This section does, however, produce silage crops, including corn, as well as the grain sorghums and sweet sorghums, which, however, are inferior to the legume hays in their calcium content. The Kansas Agricultural Experiment Station at Manhattan, Kan., recently conducted a series of experiments using ground limestone in nonleguminous cattle-fattening rations. The results of these experiments over a three-year period showed an advantage of adding calcium carbonate, either as straight calcium carbonate or finely ground high calcium content limestone, to a calf-fattening ration consisting of corn, cottonseed meal, cane silage, and prairie hay. In another experiment the tests showed the possibility of using silage alone as the roughage portion of cattle-fattening rations when supplemented with a high calcium content powdered limestone. Limestone for use in cattle-fattening rations should contain a minimum of 95 percent calcium carbonate. Limestone suitable for cattle feeding in Ellis county is found only in the Fort Hays member of the Niobrara formation. Four of the ten samples taken from the Fort Hays member ran above 95 percent calcium carbonate, which indicates that a supply of limestone of cattle-feeding quality is available in this county.

At the present time the most important economic use of the rock of the Upper Cretaceous System of this county is that of building stone. Most of the churches of the county and the buildings on the campus of the Fort Hays Kansas State College are built of native stone. The Fort Hays limestone member and the Greenhorn limestone formation yield a grade of stone that has proved very satisfactory for building purposes.

As can readily be seen, the natural resources of this county in regard to its rock deposits are great. We may say that the natural resources in this regard far outweigh the present need. Generally speaking, the lime content of the rock of the Upper Cretaceous system in this county is high, but the lack of ready market and the high cost of transportation to industrial centers make the economic value at present, in most instances, only a dormant possibility.

The accompanying map of Ellis county shows the distribution of the samples used. The numbers on the map refer to table I.

Table I shows the calcium content of the samples and the calculated lime and calcium carbonate of each. Table II affords a comparison of the lime content of the various members.

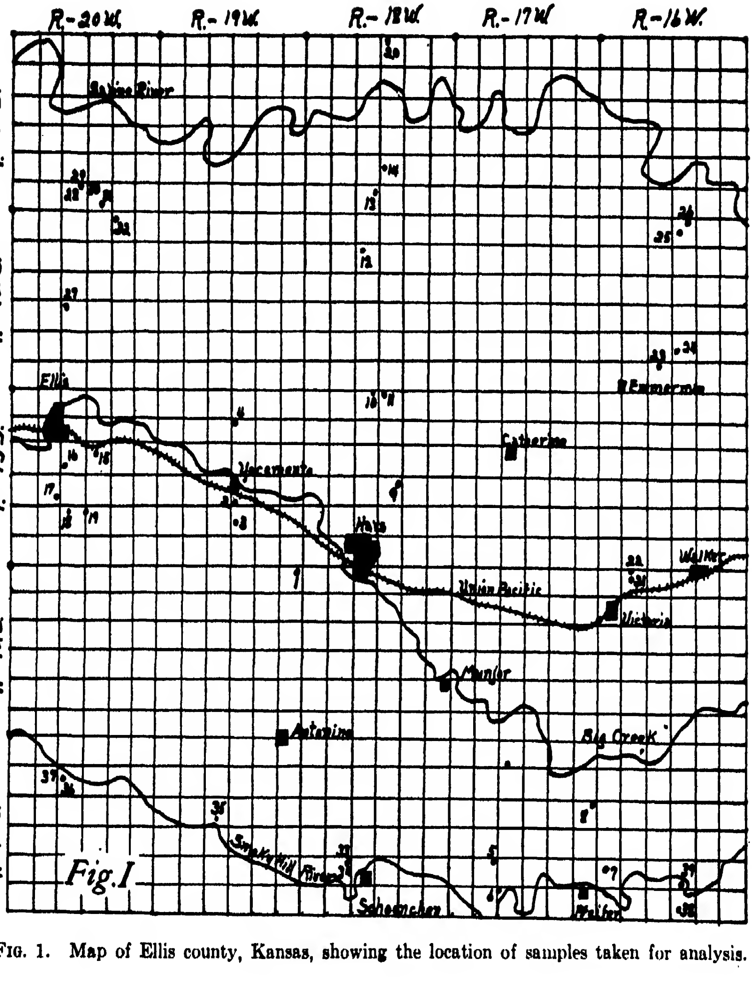

FIG. 1. Map of Ellis county, Kansas, showing the location of samples taken for analysis.

Sample number.	Section.	Township.	Range.	Percentage of lime.	Percentage of calcium.	Percentage of $CaCO_3$.
1	1	14 S	19 W	48.36	34.55	85.86
2	22	13 S	19 W	.31	.228	.568
3	27	13 S	19 W	46.92	33.63	83.56
4	10	13 S	19 W	52.90	37.84	94.50
5	29	15 S	17 W	52.39	37.40	92.95
6	32	15 S	17 W	52.29	37.38	92.88
7	30	15 S	16 W	51.73	37.02	91.99
8	13	15 S	17 W	51.69	36.93	91.75
9	22	13 S	18 W	53.94	38.55	95.80
10	4	13 S	18 W	52.14	37.31	92.70
11	3	13 S	18 W	53.71	38.39	95.40
12	9	12 S	18 W	46.20	32.95	81.86
13	33	11 S	18 W	52.76	37.68	93.63
14	27	11 S	18 W	.355	332	.799
15	15	13 S	20 W	52.67	36.76	93.50
16	16	13 S	20 W	49.00	35.02	87.00
17	20	13 S	20 W	47.11	33.77	83.88
18	28	13 S	20 W	51.36	36.56	90.89
19	28	13 S	20 W	44.60	31.76	78.94
20	3	11 S	18 W	50.85	36.31	90.22
21	5	14 S	16 W	48.40	36.23	86.01
22	5	14 S	16 W	47.08	33.61	83.56
23	33	12 S	16 W	54.26	38.78	96.37
24	27	12 S	16 W	52.85	37.77	93.85
25	3	12 S	16 W	49.40	35.30	87.50
26	3	12 S	16 W	27.11	19.37	48.16
27	21	12 S	20 W	45.38	32.44	80.60
28	33	11 S	20 W	39.88	24.82	64.60
29	33	11 S	20 W	49.80	35.60	88.40
30	33	11 S	20 W	48.69	34.79	86.46
31	34	11 S	20 W	50.07	35.78	88.93
32	2	12 S	20 W	54.18	38.72	96.20
33	29	15 S	18 W	51.76	36.99	91.93
34	29	15 S	18 W	40.19	28.72	71.37
35	16	15 S	19 W	51.21	36.60	90.95
36	9	15 S	20 W	26.87	19.20	47.71
37	9	15 S	20 W	46.17	32.97	81.96
38	34	15 S	16 W	49.88	35.65	88.59
39	27	15 S	16 W	43.00	30.74	76.37

TABLE I.—Indicating sample number, location of samples, and percentage of lime, percentage of calcium, and percentage of calcium carbonate in each (the percentages based on two or more concordant analyses each).

TABLE II.—Indicating percentage of lime content in various members

Niobrara formation.				Carlile shale.									
Smoky Hill.		Fort Hays.		Blue Hill shale.		Fairport chalk.		Greenhorn.		Graneros shale.		Dakota sandstone.	
Sample.	Percentage.	Sample.	Percentage.	Sample.	Percentage.	Sample.	Percentage.	Sample.	Percentage.	Sample.	Percentage.	Sample.	Percentage.
4	52.95	1	48.36	2	.31	21	48.40	5	52.35	38	49.88	39	43.00
10	52.20	3	47.1	14	.355	22	47.08	6	52.33				
12	46.20	9	53.95			25	49.40	7	51.80				
16	49.00	11	53.68			26	27.11	8	51.67				
17	47.11	13	52.76			35	51.21	33	51.76				
18	51.36	15	52.67			36	26.87	34	40.19				
19	44.60	20	50.85			37	46.17						
27	45.38	23	54.26										
28	39.88	24	52.85										
29	49.80	32	54.18										
30	48.69												
31	50.07												
Averages,	48.27%	52.06%		.332%		42.32%		50.02%		49.88%		43.00%	

The Bromine and Iodine Content of the Subsurface Waters of Russell, Ellis, and Trego Counties, Kansas

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Considerable has been published dealing with bromine and iodine in connection with deep wells and with sea water. To the knowledge of the author nothing has been done or published pertaining specifically to the oil-well waters of this area. The presence of these elements is usually regarded as indicating that the waters have been derived from an ocean. These elements were determined in connection with oil-well water analysis and rather definite variations in concentration between certain horizons were found to exist.

Bromine was determined by liberating the bromine from its compounds by use of chromic and sulfuric acids. The free bromine was separated into a solution of potassium iodide, thus liberating iodine which was titrated with standard sodium thiosulfate and reported as bromide. Iodine was liberated from its compounds by phosphoric acid and sodium nitrate, and was collected in carbon tetrachloride. The color of the extract was compared with standards prepared from pure iodine dissolved in carbon tetrachloride.

These elements were not determined in the waters originating above the Dakota formation. The waters of the Dakota and Cimarron inclusive usually gave negative results, though a few showed traces of both elements. (Table 1.)

The highest concentrations were encountered in the formations of the Wabaunsee and Topeka, inclusive. In one well south of Russell, at a depth of 2,120 feet, 513 p.p.m. of bromine and 12 p.p.m. of iodine were found. East of Hays, at 2,970 feet, 404 p.p.m. of bromine and 10 p.p.m. of iodine were encountered. West of Ellis, in Trego county, at a depth of 2,150 feet, the water showed 434 and 12 p.p.m., respectively, of bromine and iodine.

The waters of the "Oswald," Missouri, and Des Moines series, contain bromine averaging about 300 p.p.m. and iodine about 10 p.p.m. Waters of this formation north and west of Hays show less of these elements. North of Wakeeney, 72 and 7 p.p.m. of bromine and iodine, respectively, were found. North of Stockton only 37 p.p.m. of bromine were found in the water pumped with the oil.

Conglomerate and Ordovician siliceous waters contain bromine between 40 and 70 p.p.m., while iodine is usually under three. Sulfides, as H_2S, usually occur in these waters; otherwise they resemble present-day ocean water.

Where more than one horizon produces water in the same series, and more than one is encountered in the same well, there usually is little difference in concentration of any of the salts.

According to Ristle (*1*): "Mrazec, writing on Rumanian oil fields, finds that all the waters associated with oil in those fields contain iodine, but little or no bromine, whereas waters that are not associated with oil contain bromine but little or no iodine." Bromine and iodine appear in certain geologic formations throughout this area, and from the results obtained, there seems to be no correlation between oil and these elements.

Trans. Kansas Acad. Sci. 39, 1936.

1. Taken from Master's Thesis: Analysis of Oil-Well Waters of Russell, Ellis and Trego counties, Kansas.

Considerable water is pumped with the oil from the Oswald and Siliceous formations throughout the area, some wells pumping as much as 90 percent water. This water is usually allowed to flow into ponds where it either is absorbed by the soil or evaporates. As the salts of these elements are quite soluble, they may become very concentrated in some of these ponds.

The quantity of these elements carried by the subsurface waters in this area is not sufficient to be of great commercial value, though with modern methods of recovery, as described by Stewart, (*2*) considerable bromine could be recovered from these waters.

Solar evaporation could be used in this area for concentration, as, according to A. L. Hallsted, of the U. S. Weather Bureau and Division of Dry Land Agriculture, U. S. Department of Agriculture, the 28-year average evaporation from an open pond is 47.682 inches between April and September. Thus, large quantities of this waste water from oil wells could be concentrated before the extraction of bromine and iodine.

Determination of bromine and iodine in the waters of this area could certainly be effectively used in identifying waters which give trouble in a producing oil well, especially in identifying waters that are very similar in mineral content.

TABLE 1.—Bromine and iodine content of subsurface waters from oil wells of Russell, Ellis, and Trego counties, Kansas

County.	Section.	Township.	Range.	Depth.	Bromine.	Iodine.	Specific gravity.
Dakota and Cimarron							
Russell	10	14	15	400	T	0	1.026
Ellis	24	12	16	280-690	T	T	1.020
Ellis	24	12	16	840-870	5	T	1.041
Ellis	15	11	17	930	T	T	1.140
Wabaunsee and Topeka							
Russell	23	14	14	2117-2132	513	12	1.131
Ellis	24	12	16	2520-2550	370	13	1.113
Trego	17	13	21	2704-2725	263	12	1.140
Ellis	3	14	17	2965-2975	406	10	1.124
"Oswald"							
Russell	16	16	14	3210	359	8	1.105
Russell	6	13	15	3060	318	9	1.089
Ellis	5	12	17	3565	268	9	1.099
Ellis	3	14	17	3288	295	10	1.112
"Siliceous"							
Russell	32	13	15	3317	45	T	1.022
Ellis	20	11	17	3420	59	2	1.038
Russell	23	15	4	3370	73	1	1.035
Ellis	5	12	17	3630	73	2	1.038

LITERATURE CITED

1. Ristle, C. E., Jr. Identification of Oil-field Waters by Chemical Analysis. Bureau of Mines Technical Paper 404. 1927.

2. Stewart, Leroy C. Commercial Extraction of Bromine from Sea Water. Industrial and Engineering Chemistry, 26: 261-269. 1934.

The Fifth Annual Summary of the Population of the More Important Insects in Kansas, Covering the Year 1935[1]

ROGER C. SMITH, Professor of Entomology, and E. G. KELLY, Extension Entomologist,[2] Kansas Agricultural Experiment Station, Manhattan, Kan.

The method of making and recording the results of the fifth annual summary differs in no important respects from the summary for 1934. The headings and form of the questionnaires were changed slightly in the light of past experience and the known conditions for 1935.[3]

SUMMARY OF THE WEATHER FOR 1935[4]

January opened with milder weather than usual, and was about normal in precipitation and sunshine.

Mild temperatures prevailed during February until the cold wave on the 24th, which brought high winds and dust storms. Drought conditions became severe, especially in the western half of the state favoring dust storms.

March was unusually mild, dry and dusty. The worst dust storm ever reported for the state occurred on the 20th. The air was so full of dust over the entire state that the use of headlights was necessary in auto travel, and street lights were turned on. The dust was said to extend to 16,000 feet in height, and visibility at the worst was less than one city block in the eastern half of the state and practically zero in the western third. Vegetation made little growth in the western half of the state because of the acute shortage of moisture.

April was unusually cool and dry, both conditions being near a record. The month was deficient in sunshine and the drought in all counties except the extreme eastern and southeastern became acute. Severe dust storms were frequent, especially in the western half of the state. May opened with crops in serious need of moisture, but heavy rains occurred on the 9th to the 11th and continued throughout May to near the end of June. May was the third wettest on record, and also one of the chilliest. June was unusually cool and wet. Serious floods occurred throughout the state, but especially in the valleys of the Republican, Neosho, Marais des Cygnes, Saline, Blue, and Kansas rivers. Manhattan experienced the second worst flood of its history on June 7, due to heavy rains in southern Nebraska, western Colorado, and northwestern Kansas. July was the driest and third hottest during the 49 years for which records have been kept in the state. The month was exceptionally sunshiny, proving detrimental to crops. The lack of rainfall was offset somewhat by the large amount of moisture in the soil.

Trans. Kansas Acad. Sci. 39, 1936.

1. Contribution No. 443 from the Department of Entomology.

2. Acknowledgments of assistance rendered are the same as indicated in the 1934 summary, except that Mr. Emil Beckman, an N. Y. A. employee, summarized the questionnaires, prepared all of the tables presented herewith, and typed the manuscript. This report embodies results obtained in connection with Agricultural Experiment Station Project No. 6.

3. Smith, Roger C., and Kelly, E. G. The fourth annual summary of the more important insects of Kansas covering the year 1934. Transactions of the Kansas Academy of Science 38:171-185. 1935.

4. Largely from S. D. Flora. Climatological Data, Kansas Section U. S. Dept. Agr. Weather Bureau. 49th year, numbers 1-12. 1935.

TABLE 1.—Summary of weather data for the state of Kansas for the period September 1, 1934, to December 31, 1935

MONTH.	Temperatures; degrees Fahrenheit.					Precipitation, in inches.					
	State average.	Maxi-mum.	Mini-mum.	Average for 49 years.	Depar-ture from normal.	State average.	Average for 49 years.	Depar-ture from normal.	Eastern third.	Middle third.	Western third.
September	65.2	102	26	69.6	−4.4	4.18	2.80	+1.38	6.97	4.12	1.45
October	62.3	97	7	57.0	+5.3	1.29	1.95	−0.66	1.91	1.30	0.66
November	47.3	87	13	43.3	+4.0	2.58	1.29	+1.29	4.84	2.24	0.66
December	33.1	72	−5	32.8	+0.3	0.42	0.86	−0.44	0.68	0.43	0.15
January	35.0	74	−19	29.9	+5.1	0.61	0.66	−0.05	1.15	0.38	0.31
February	38.8	84	−10	33.2	+5.6	0.79	1.01	−0.22	1.24	0.89	0.25
March	51.0	90	0	43.2	+7.8	0.82	1.44	−0.62	1.10	0.76	0.61
April	52.3	90	20	54.7	−2.4	1.13	2.59	−1.46	2.13	1.02	0.25
May	59.0	98	27	63.7	−4.7	7.78	3.77	+4.01	10.22	8.46	4.65
June	71.0	104	38	73.7	−2.7	5.08	4.00	+1.08	7.30	5.05	2.90
July	84.3	113	53	78.8	+5.5	0.68	3.24	−2.56	0.47	0.76	0.80
August	80.4	112	43	77.5	+2.9	2.95	3.17	−0.22	4.55	2.79	1.50
September	69.1	102	31	69.5	−0.4	3.17	2.81	−0.36	4.18	3.04	2.29
October	56.1	91	17	57.0	−0.9	2.88	1.97	+0.91	4.96	2.22	0.58
November	40.2	75	3	43.3	−3.1	2.31	1.31	+1.00	3.86	2.07	0.99
December	33.8	65	−3	32.8	+1.0	0.27	0.85	−0.58	0.43	0.23	0.16
Totals for the calendar year, 1935						28.47	26.82	+0.93	41.59	27.67	15.29

It is a common statement that a cool June is followed by a cool July, but 1935 proved to be an exception, for July was extremely hot and dry. The July rainfall in Riley county was the least in the 70-year period. Temperatures in July and August might have been higher in 1935 if the fields and pastures had not remained green. The feed for domestic animals in central Kansas was ample. Due to rainy weather, corn was tall enough to make feed, but not much grain.

Abnormally hot, dry, and sunshiny weather prevailed during the first nineteen days of August, followed by lower temperatures, heavy rains and considerable cloudiness during the closing days. In September more rainfall than usual fell over most of Kansas, and mild sunshiny weather prevailed. By the close of the month, the upper soil, except in part of the southeastern and southwestern counties, was well saturated with moisture. During October there were frequent and heavy rains over the eastern half of the state, which penetrated the subsoil two to six feet, but the southwestern section remained dry. Abnormally cool weather, with generous rains and excessive cloudiness except in western counties, prevailed during November. The eastern third was thoroughly soaked by the rains, though the southwestern counties remained dry.

The year closed with ample rainfall, which gave hope that the drought which had lasted five years might be terminating.

SUMMARY OF CONDITIONS OF CROPS AND OTHER VEGETATION DURING 1935 [5]

Wheat made slow growth during the spring, and by the time rains came in May it was permanently injured. The rains brought about considerable visible improvement, and viewed from the roads the crop over most of the state appeared excellent, but the heads were poorly filled and much of the grain was shriveled, partly due to stem rust. The total yield of the state was estimated to have been 59,951,000 bushels. With the exception of 1933, this was the smallest yield since 1917. Only about 50 percent of the acreage was harvested.

Conditions were exceptionally favorable in all but the extreme western counties for fall sowing of wheat, and excellent stands were obtained in nearly all counties.

Corn production was well above that of 1934, but far below the five-year average, the total production from 4,608,000 acres being only 34,560,000 bushels. Planting in many cases was delayed in April and May because of the dry soil. After the rains started, the soil was so wet that planting was impossible until later than the usual planting date. Many of the fields were weedy and the crop was late. Most of the grain did not mature, contained excessive moisture, and much of it was below marketable quality.

The oat crop of 41,022,000 bushels was the largest crop since 1931, and more than 6,000,000 bushels above the five-year average. The heavy rains and cool weather of May and June were favorable to this crop.

The growth of alfalfa was slow during the spring, but rains came in time to produce a fairly good first cutting in the eastern part of the state, of which some could not be harvested because of the wet weather. The second cutting

5. Largely from "Kansas 1935 Crop Review," U. S. Dept. Agriculture Bulletin of Agriculture Economics. Dec. 22, 1935. Topeka, Kansas; and the Kansas Weather Summary for 1935 by S. D. Flora.

was medium and the third was small in all but the eastern counties, while the last cutting in spite of late summer rains was light. The stands in most of the fields of the state were in excellent condition for winter. The yield of alfalfa seed was 144,000 bushels, an increase of 20 percent over 1934.

Grain sorghums produced a crop of 9,940,000 bushels, which is nearly three times the short crop of 1934 but only about two thirds of the five-year average. Sweet sorghums produced nearly twice the tonnage of 1934, but harvesting in some fields was hampered by wet fields.

The potato crop of 2,625,000 bushels was nearly twice that of 1934, but the yield of many acres in the Kaw valley was lost or severely damaged by floods in June.

The summer tomato crop in Kansas was almost a total loss, due chiefly to the hot, dry weather. The fall crop from plants planted in late summer was good.

The apple and peach crops of 1935 were nearly twice that of 1934.

In general, Kansas crop yields for 1935 were far below average, but above those of 1934. The total was the largest since 1931. It was the second consecutive year in which the combined production of the state's two leading crops (corn and wheat) was less than one third of the five-year average (1928-1932).

There was a noticeable increase in the number of cactus plants over the western half of the state, and the spread of the plant eastward was marked. This spread occurred also during the drought of 1913, according to Professor Dean. There was also an increase in bindweed throughout the state. Much interest was shown in controlling these weeds by biological methods. Bindweed was severely attacked in Riley and Jackson counties by red spider and by several species of small moths during 1935. Professor Wilbur noted the great increase of little barley (*Hordeum pusillum*) in the pasture region of the eastern third of the state, culminating last year.

Many shade trees dropped some of their leaves during June, July and August. Apparently the trees put out too many leaves during the rains of May and June, so were forced to drop some leaves with the advent of hot weather.

Bees produced a better crop of honey during 1935 than for three or four years. Many beekeepers had trouble with overswarming. It was necessary to feed colonies from March to May, since much of the time the weather was too cool for bees to fly. The heavy rains of May and June caused an overstimulus, resulting in swarming. The hot, dry weather coming about July 6 caused the honey flow to stop suddenly and some colonies could scarcely maintain themselves.

There was a heavy growth of smartweed during September, which enabled bees to store enough honey for winter. The 1935 honey crop in the better yards of eastern Kansas averaged 125-150 pounds per colony, but the honey was dark in color.

Source of Material

The number of summarized replies to the July and October questionnaires is as follows:

Group I. Entomologists residing within the state: 12 reports in July; 17 in October.

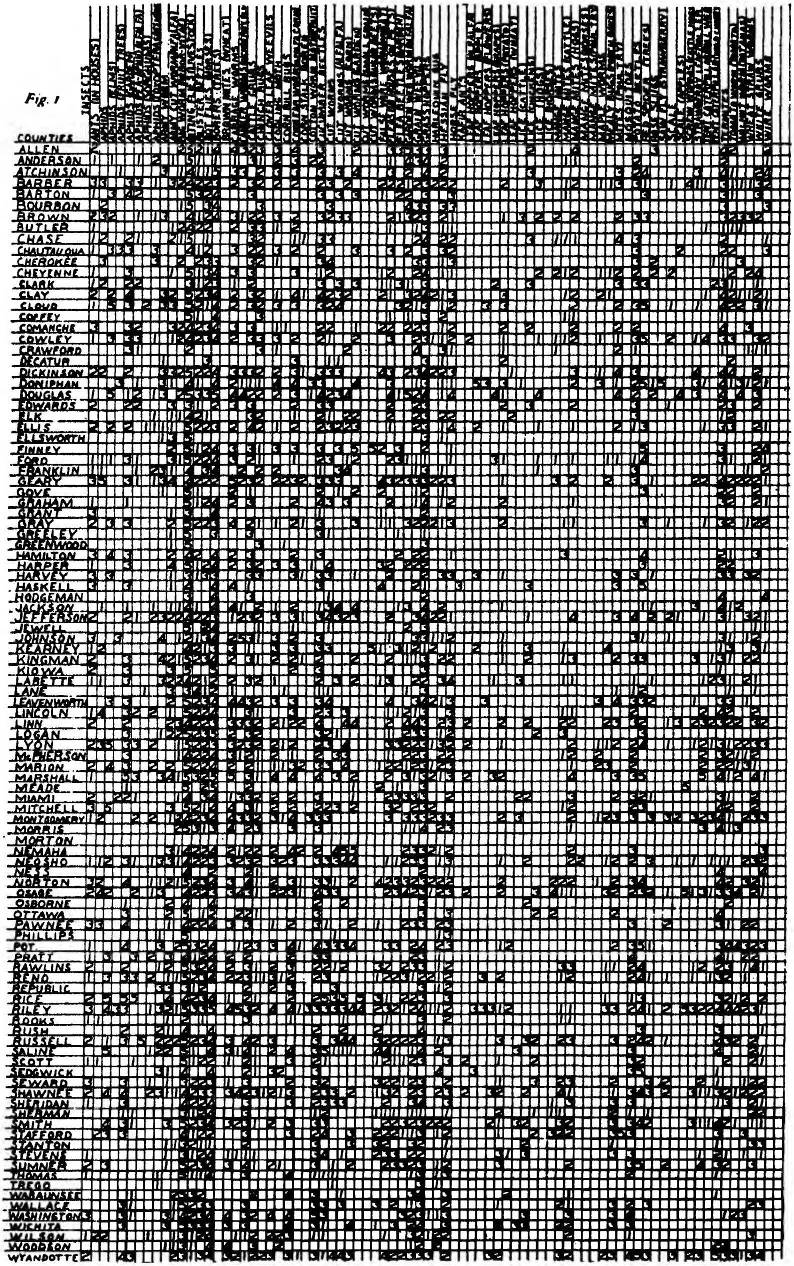

FIG. 1. Table showing insect reports by counties.

GROUP II. County Agricultural Agents of the state. Of the 99 in the state, reports were received from 84 in July and 80 in October.

GROUP III. Leading farmers selected: 7 replied in July, and 22 in October. Vocational Agriculture Teachers: 35 reports in July; 21 reports in October.

Summary July reports, 138; October, 140. Total, 278.

The final index numbers for all counties and all insects represented in the reports are shown in Fig. 1. These summary numbers, which were in all cases decided upon by the authors, are generally averages of all reports, with the fractions eliminated by choosing the next whole number above or below, depending on conditions in other counties of the same crop area and additional facts known to the authors.

OBSERVATIONS ON THE POPULATIONS AND CLIMATIC RELATIONSHIPS OF SOME OF THE INSECTS

ALFALFA CATERPILLARS were plentiful during the summer. The well-known polyhedral disease was somewhat less destructive than last year and the yellow butterflies again reached about normal numbers after a marked decline in 1934.

The KAFIR ANT (*Solenopsis molesta* Say) caused injury to seed corn and kafir in early June in Riley and Ottawa counties. The insect was also reported injuring sorghum seed at Severy, Kan., during July.

APHIDS

GREEN BUG (*Toxoptera graminum*) occurred in many fields in Montgomery county April 19. On May 9 the aphids were abundant in Comanche, Kingman, and Pratt counties on wheat, oats and *Hordeum jubatum*. A few fields of wheat in the state were destroyed and others were observed to have been damaged. Aphids of this species appeared in Dr. R. H. Painter's fly nursery at Manhattan in May, but there was no damage done in Riley county by this species.

Green bug was readily found in December, 1935, in volunteer oats in Bourbon, Allen, Wilson, Woodson, and Coffey counties. No volunteer oats survived the winter.

PEA APHIDS were not found in the state until March 18 in alfalfa fields around Manhattan. A small infestation was reported near Ottawa (Franklin county) during the latter part of March and early April, but no damage was done. A few scattered aphids occurred in many alfalfa fields during May, especially in southeastern Kansas, and on garden peas and beans in Harper county in early May. A field of alfalfa at Sedan, Kan., was reported so severely damaged by aphids that the first cutting was lost. These insects increased very slowly in Riley county, and by the middle of May only scattering females, about 20-100 in 25 sweeps of a net occurred. No damage was done in the county. So far as observable, the dust on alfalfa plants did not affect the aphids adversely.

Lady beetles were scarce until about midsummer, due, it is thought, to starvation and cannibalism following their spectacular destruction of the pea aphid outbreak in April, 1934.

May and June were characterized by large populations of a number of species of plant lice. The pea aphid was plentiful and increasing in alfalfa fields

up to about June 15. While not doing perceptible injury, the population continued larger than usual in the summer because of the cool, wet May and June.

Pea aphids were readily found in local fields in larger numbers than usual up to July 17. They were reported to have occurred in small numbers in some alfalfa fields in southeastern Kansas during December, but Messrs. Painter and Jones could not find specimens to establish greenhouse colonies for experimental work. The aphids were reported present locally in Bourbon, Allen, Wilson, Woodson, and Coffey counties in the fall. No eggs were seen during the fall.

The Elm Leaf Aphid (*Tuberculatus* (Callipterus) *ulmifolii* (Monell) occurred in outbreak proportions beginning in early June in the eastern half of Kansas, as far west as Beloit. The aphids clustered on elm foliage, apparently preferring older trees which had been previously weakened by borers, cankerworms and drought. Many of these trees were killed immediately, while others dropped a portion of their foliage and were further weakened. At Manhattan, many elms not previously killed by borers along the older streets, as Juliette and Bluemont, were promptly killed, and the appearance of the streets was radically changed. A similar situation was reported from Hutchinson, Lindsborg, Emporia, and Pittsburg. Automobile owners were much annoyed by the honey dew on their cars, especially on the windshields. The molted skins and honey dew were conspicuous on elm foliage during July. The leaves of many elms turned somewhat olive brown and remained so during the rest of the year. Lady beetles attained normal numbers about the middle of July and the aphids were promptly brought under control largely by them.

Tomato Aphids were exceptionally plentiful during 1935, according to Professor Dean. The varieties of tomatoes, including the so-called wilt and mosaic resistant ones, went down from the mosaic, which is spread by aphids, and from the hot, dry weather.

The Redbud Aphis (*Aphis pawneepae* Hottes)[6] was found May 8 by Dr. H. R. Bryson on redbud trees in Riley county for the first time, though there is some evidence that this same species occurred on a redbud tree on the college campus last year. These purple, mealy aphids clustered thickly on the underside of the larger branches.

Cabbage Aphids began to appear on radishes, turnips, and cabbage the last of April in large numbers in Riley, Harper, and Kingman counties. Damage was done chiefly to young plants.

The Black Peach Aphid was abundant during April and May, especially on water sprouts of plum trees in Riley and Kingman counties.

A black aphid appeared in numbers on grape clusters at Manhattan about June 12.

Corn Leaf Aphids were abundant on kafir heads and did serious damage in Jewell county in September, but in general this species was not plentiful in 1935.

Aphids on honey locust were observed in numbers in Kingman county, May 9.

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6. Hottes, F. C. Aphid Description and Notes. Proceedings of the Biological Society of Washington. 47:3, 1934.

A species of aphids was observed in abundance on tulips in Labette county on April 18, causing slight injury.

The ROSE APHID (*Macrosiphum rosae*) was observed on the new growth of roses in Riley, Labette, and Franklin counties during April.

The MELON APHID was abundant at Manhattan and at Sylvia during July. It did considerable injury to late squashes, cucumbers, and melons in Riley county during September.

APPLE TREE TENT CATERPILLAR eggs were observed in large numbers on wild plum and sand plum, March 1 to 4, in Ford, Edwards, Comanche, Gray, and Finney counties. By the middle of April, many webs of this species were observed on choke cherry and wild plums in Montgomery, Crawford and Neosho counties.

BLISTER BEETLES were first reported injuring potatoes at Ada (Ottawa county) in early July. A few colonies of these insects were in evidence, feeding chiefly on weeds at Hays by the middle of July.

BED BUGS were common in hen houses in Clay, Cloud, Washington, and Russell counties during January and February.

BORERS, particularly the flat-headed apple-tree borers, were far more plentiful and more destructive in the state during 1935 than in any previous time in the history of insect work in the state. The correspondence about borers was exceptionally heavy, averaging perhaps about ten letters a week during the summer. Many shade trees and shrubs never known to be attacked in the state were injured. Small apple and other fruit trees in the nurseries, one and two years old, were killed or damaged by the flat-headed apple-tree borer. The infestation in nurseries caused an estimated damage of from 20 percent to 90 percent to two-year-old trees. The heavy rainfall in September and October resulted in an increase of sap in trees and a large percentage of borers were drowned in their burrows.

Frequent comment has been made that few trees were destroyed by borers during the great drought of 1913 which was preceded by the dry years of 1911 and 1912. The trees are now more than 20 years older and their moisture requirements are correspondingly increased over that of 1913. The moisture in the subsoil has been exhausted by the larger and more thickly planted trees. More paving has been done, causing a larger water runoff or less surface area for absorption of moisture by the soil. The trees were largely dependent on surface moisture due to lack of subsoil moisture.

Juliette street in Manhattan had two rows of trees in each parking and nearly all the trees died. A single row would have fared better. The trees had been weakened by three or four years of canker worm injury.

HORSE BOTS were more numerous in western Kansas than in 1934, but less numerous in the eastern half of the state. In some cases, inadequate and poor food for horses contributed to the serious results of this infestation. Some horses are known to have died during January and February from injuries by all three species of bots, but especially nose bots, in northwestern counties. Bot eggs were exceptionally numerous on horses during the summer in southwestern Kansas.

BOXELDER BUGS were practically absent during the spring. Not one was observed on the south side of the college buildings during January and February when ordinarily they would be present by the thousands on warm days. By the middle of May, only a few—less than a half dozen—had been seen.

CANKERWORM MOTHS began emerging at Manhattan during the first ten days of the year. Spring canker worm moths were appearing by the middle of January. Practically all the trees were banded by January 25 and large numbers of moths were caught before February 1. A low temperature of 11° below zero during January retarded emergence.

By February 23 many bands were covered with moths. Most bands had been renewed once or twice. The peak of emergence occurred about the last of February. Bands with 400 to 600 moths on them were observed in Wellington on March 7. At Concordia a group of elms were banded on April 1 and on April 2 a good catch had been made. Emergence continued until the last of March. A heavy emergence occurred March 17 in Riley county. The band collections indicated a larger population than occurred during the spring of the previous year.

Widespread banding was done in Harper county. Cankerworms were scarce in early May, and by the last of May little foliage damage was occurring in Manhattan. Larvae one half inch long were observed April 17 in Montgomery county. By May 10 many trees in Manhattan began to show injury. The larvae were one third to two fifths grown at that time.

Cankerworms were full grown by June 15. The heavy rains of May and June brought out heavy foliage on trees. Trees on the Leavenworth Military Reservation were severely damaged by cankerworms. This insect was scored at 3 for Leavenworth, Miami and Cowley counties.

CABBAGE WORMS (*Ascia rapae L.*) were very plentiful at Manhattan during June and July. They were also reported destructive at Mound Ridge, Blaine, and Melvern, Kan.

The SOUTHERN CABBAGE LOOPER reached at least normal numbers during the summer in Riley county and in September was abundant on fall-sown lettuce.

Following the flood and rains of early June, a large number of the CARABID BEETLES (chiefly *Calosoma* sp.) were observed in the gutters and on the downtown sidewalks of Manhattan, where they wandered upon being attracted to lights at night.

The CARROT BEETLE (*Ligyrus gibbosus*) was reported causing injury in a garden at Coolidge (Hamilton county). Similar injury had occurred in the same garden in previous years.

CATTLE LICE, chiefly the short-nosed ox louse, were very plentiful in January and February in Clay, Cloud, Washington, and Russell counties. They were scarce in the southwestern counties at that same time. The infestation continued until April. They were observed on small calves in Cloud county early in January and in outbreak numbers on six herds in Clay county in April. Biting lice were also plentiful on these herds.

Lice were observed to be very plentiful in Ellsworth, Labette, Montgomery, Neosho, and Crawford counties during the month of April. Many cattle were in poor condition and the lice caused them to rub the hair from their bodies, and thus the cattle were left unprotected.

CATTLE GRUBS were more plentiful than average in western Kansas, especially in the northwestern counties, during January and February. According to the extension entomologist, larvae began dropping out as early as January 25.

Cattle grubs had nearly all dropped from the cattle by April 5 and the flies were observed chasing the cattle. However, in Ottawa county, flies caused

calves to run as early as March 28. They were out about the same time in Ellsworth, Labette, Neosho, Montgomery, and Crawford counties. Early in March the grubs had not all dropped out in Finney, Gray, and Comanche counties. No cattle had been seen running up to March 4.

CHINCH BUGS were fairly plentiful during the spring of 1935. In February the numbers overwintering in bunch grass and in wheat were about average. Winter conditions were favorable for them and the winter mortality was small. In the spring they developed to the point that some injury appeared certain, when the heavy rains of early June destroyed large numbers of them. The hot, dry weather which followed destroyed others. Chinch bugs were not plentiful in Riley county in early June and only a few eggs were laid up to June 15.

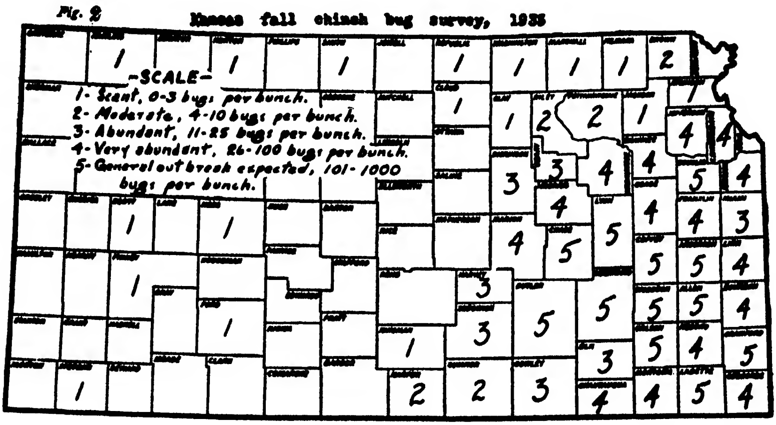

FIG. 2. Kansas fall chinch-bug survey, 1935.

There was some chinch-bug disease in the state, and the hard June rains apparently destroyed many bugs. These insects were scarcer at harvest time in the state than they have been for several years. Few barriers were built in the state.

A striking feature of the chinch-bug life history in 1935 was that the overwintering bugs lived so long in the summer and deposited eggs so late. There were overwintering bugs in wheat and cornfields of Riley county up to July 15 which had not yet laid their full quota of eggs.

Chinch-bug insects could be readily found in September, but the numbers in Riley county appeared to be about normal. Some injury to cane, kafir, and sudan grass, particularly in Ottawa, Shawnee, Coffey, Bourbon, Woodson, Wilson, Cowley, and Harper counties occurred during the fall. There was also damage to kafir, cane, and corn in Lyon county during the fall. Only a little fall burning was done up to the close of the year, because of the fall rains.

During the fall survey a few chinch bugs were observed feeding in alfalfa and cane in Rawlins, Norton, Scott, Ness, Finney, Gray, Ford, and Stevens counties. (Fig. 2.) These bugs were near the barns where cane and corn fodder transported from eastern Kansas during the winter and spring of 1934

was fed to cattle. It appeared that the bugs had been transported with the fodder to these sections where chinch bugs do not normally occur.

The usual numbers of CLOVER LEAF WEEVIL larvae were found during February in alfalfa fields of Riley county, They were very small, being in the first or second instar. The dry weather later was unfavorable to them. The larvae injured leaf buds in Franklin county in early April, but for the year the population was below normal and their damage was inconsequential.

CODLING MOTHS were below normal in population in the apple district, according to Mr. R. G. Yapp. While there was still a fairly large codling-moth population, in general codling-moth control in orchards was better than usual and the fall population was somewhat below that of last year.

Codling moths were delayed about a month in their normal life history. The peak of the second brood was reached in northeastern Kansas about July 27, which is about a month late.

CORN EAR WORMS were again very numerous and destructive during the year, causing injury to 99 percent of the ears of corn in Riley county. The first generation was slightly less plentiful than last year, but the species increased rapidly, so that there was scarcely an ear of corn produced in the state which did not show some damage by ear worms.

The so-called rag-worm or heart-worm injury occurred on about 15-25 percent of the plants in Riley county, but at Hays, according to A. L. Hallsted, as many as 32 percent of the plants were affected. Since much of the corn was planted late, the second generation in part was involved in the rag-worm injury.

Ear worms were plentiful on tomatoes and in alfalfa during July in Riley county.

In September the larvae were plentiful over the entire state, and reached a high point in population for the year. The chief fall damage was done to the heads of kafir and foliage of alfalfa. The larvae were present in local truck patches in large numbers and damaged tomatoes and beans.

CORN BILL BUGS were serious pests in the Neosho, Verdigris, and Cottonwood river valleys during the early summer of 1935. Some farmers reported a complete loss of their corn crops in some fields.

The SEED-CORN BEETLE (*Agonoderus pallipes*) was less common around lights this year than usual, though occurring in considerable numbers at Manhattan, July 15.

An abnormal number of calls for methods of controlling BLACK CRICKETS in houses came in during the fall. Locally, it appeared that crickets in basements were a problem in nearly every home. The situation was probably favored by the heavy rains during the last of August, which made many basements cool and damp, and the abnormally warm weather during the most of September, such that crickets sought the damp, cool basements.

The CURRANT WORM (*Pteronidea ribesii*), while observed in Riley county, did no appreciable damage anywhere in the state.

FLIES: STABLE, HORN, AND SCREW-WORM

BITING FLIES on livestock appeared only in normal numbers or less during the early spring. The dry weather was not favorable to them. They were first observed in attacking cattle for the first time in the year on April 4, in

Washington and Clay counties. The biting flies and the house flies were very troublesome at Manhattan and Hays during early July.

The three species of flies, however, occurred in the worst outbreak perhaps since 1912, from the latter part of August to October. Milk production dropped 20 to 60 percent. Teams could not be taken to the fields for several weeks because of the flies. Repellant fly sprays were of little value and many farmers worked their teams at night. A creamery in Chase county reported a drop of 30 to 40 percent in milk and cream coming from farms, beginning August 28, increasing until September 15. In Logan county the outbreak appeared suddenly on August 27 and continued until October 1, with reductions of 50 percent in milk production commonly reported.

Some injuries to cattle occurred in Bourbon county by applying certain homemade fly sprays too heavily. The stable fly was the dominant species, but horn flies were likewise abundant. House flies attained a population peak for the year during this same period. The heavy rains of August started fly breeding, particularly around the barns, and the flies began emerging about August 20. Piles of weeds and decaying straw washed together by the floods constituted important breeding places for the flies. They bred also in old strawstacks and in barnyards in great numbers.

Counties reporting severe outbreaks of biting flies in September were: Lyon, Logan, Mitchell, Osborne, Gove, Riley, Wabaunsee, Shawnee, Rooks, Elk, Montgomery, Neosho, Cowley, Marion, Jewell, Smith, Norton and Geary.

Flies were exceedingly bad in Osborne county. They appeared to be worse near streams of water than in pastures four to six miles from streams. This was further evidence that rotting straw and vegetation along streams contributed materially to the fly outbreak. Calves lost weight in Lincoln county every day during the outbreak. The flies were observed to persist in their attacks on cattle in darkened barns in Ottawa county.

Geary county had the worst biting-fly outbreak ever experienced. Hundreds of gallons of fly sprays were used. Milk losses were estimated at 50 to 75 percent, in spite of an abundance of succulent pastures resulting from the copious late summer rains. A cheese factory at Junction City normally running seven to nine vats a day dropped to four on August 27 and to one on September 5. It returned to two or three per day by November 1. It was reported that the 1,500-pound horses at the Fort Riley cavalry school lost 250 to 300 pounds each between August 28 and October 1. Regaining of this weight was slow. Fly-fighting activities caused an increase in the number of injuries to more than double the usual number of cases brought to the veterinary hospital.

Marion county reported the worst outbreak of biting flies in its history. There was a decrease in cream receipts of 20 to 25 percent on September 1, and this reduction was not recovered during the fall.

Screw Worm Fly infestations of cattle, horses, hogs, dogs, and even man were more numerous in Kansas during 1935 than in recent years. The outbreak lasted from August to November, and was widespread over the entire state, being probably worst in about twenty central and southern counties. There were two or three cases per day at the local veterinary clinic. Cattlemen rode through pastures daily with jugs of benzol or chloroform and pine tar oil with which to treat wounds of animals. It was estimated that there were over 2,000

cases of screw-worm infestation in Morris county, but there was no death loss. One druggist in Council Grove sold in small lots to farmers 14 gallons of benzol and nine gallons of chloroform for screw-worm control. It was estimated that there were over 1,200 cases in Lyon county. Five calves died on August 27, and 20 lambs died out of 55 which were infested in a flock of 140 near Admire. More than 100 farmers in Geary county had 800 cattle or hogs infested with screw worms, the outbreak being the worst since 1933.

Screw worms were bad in Marion county, 1,000 to 1,200 cases occurring, according to a veterinarian residing in the county.

A man is reported to have died in Coffey county during September from nasal infestation of screw-worm fly larvae. A fly was reported to have been mashed on his face and larvae set free. While there was no open wound on his face, the larvae entered the frontal sinus and death resulted in five days.

The sheep-blow fly was reported to have attacked sheep in the flanks in Coffey county in May.

Cut Worms, Including Army Worms

About the usual numbers of Army Cut Worms were found in the alfalfa fields in Riley county during February. They were not plentiful enough to presage any injury of consequence.

The first reports of an outbreak, with damage to wheat, came from Comanche (Coldwater) and Kiowa (Greensburg) counties on March 4. An outbreak was reported in Riley county and Ellsworth county March 13, but a survey of supposedly seriously infested areas in Riley showed only the normal number of cut worms present. An infestation was reported, because severe fall pasturing of alfalfa and the dry spring resulted in only feeble growth from the clumps which the few worms present damaged. Frost earlier in March had also killed some of the new growth which was blamed on cut worms. The larvae collected in patches of bluegrass and wild mustard.

In a 500-mile survey trip, on April 3, through Pratt, Barber, Kingman, Neosho, Republic, Cloud, and McPherson counties, 12 alfalfa and 14 wheat fields were found to be heavily infested, one to eight cut worms being found in practically every clump.

Dust furrows were used in some southwestern counties to stop the migrations into full-sown wheat, barley and rye. Excellent results were obtained in all parts of the state from bran mash, particularly that sown in alfalfa fields.

In Riley county the larvae sometimes concentrated in patches of wild mustard. Alfalfa, sweet clover, and wheat were damaged in Franklin and Clay counties and the grasslands in Ottawa county showed some damage. In Ottawa county they were observed in early April moving out of grassland and stubble fields into wheat and alfalfa, injuring some stands severely. They were also observed in considerable numbers in Harper, Morris, Edwards, Finney, Hodgman, Ford, Gray, Clark, and Comanche counties.

During June (June 15) there was a heavy flight of cut-worm moths in Riley county. They hid in trees, stone piles, and in outbuildings during the day in large numbers and began to fly in the early evening. The flight indicated a considerable population of army cut worms earlier.

Somewhat more than the usual number of *Feltia subgothica* larvae (the dingy cut worm) were found in alfalfa fields during February in Riley county.

They occurred with the army cut worms in grass plots during March. Some injury was done by this species to alfalfa in Jackson county in early April, according to Mr. Walkden. Aestivating larvae in rearings at Manhattan were of this species.

The WHEAT HEAD ARMY WORM caused some injury to wheat in the wheat belt of the state, being reported at Manhattan and Great Bend during June and early July.

The VARIEGATED CUT WORM did no appreciable damage in alfalfa, largely because of the excellent growth of alfalfa following June rains. This species of cut worm was fairly plentiful in northeastern Kansas during June, according to Mr. H. H. Walkden. The population there was rated at 2.

The COTTON CUT WORM or yellow striped army worm began to appear in numbers about July 15. It was plentiful in Riley county during July and it was also reported from Lebanon.

The COTTON WORM MOTH arrived earlier from the south than usual at Manhattan, the first specimens being taken at lights on August 30.

The true ARMY WORM was more plentiful than usual during 1935. A heavy flight of moths occurred during May and more larvae than usual were taken in alfalfa and wheat during June. Slight injury was done to the beards of maturing wheat in northeastern Kansas, according to Mr. H. H. Walkden. On March 9 some army worm moths were observed out for a week or more; however, they were scarce.

A flooded field of corn and sorghum along the Kaw river in Riley county was severely damaged by the BLACK CUT WORM (*Agrotis ypsilon*) during the latter half of July. The stand was almost wholly destroyed.

FALSE CHINCH BUG nymphs appeared in more than ordinary numbers during the middle of April in Franklin county. The adults were observed in numbers early in May in Harper county.

FALSE WIRE WORMS extended much farther eastward this year than usual. The larvae and adults did damage as far east as Riley county, while in other years Abilene represented about the eastern edge of damage. This shifting of activity eastward is very likely a response to the five dry years just past. False wire worms were first reported injuring corn at Orion, Kan., early in July. They were observed feeding upon fall-sown wheat and volunteer wheat at Junction City. Injury to wheat was reported from Hodgman county up to September 25, when rains caused the wheat to sprout.

FLEAS were a little more plentiful than usual in homes during May and June. They occurred chiefly in basements. These pests apparently increased in population during July and continued plentiful until cold weather.

GRASSHOPPERS were clearly on the increase in population during 1935. The low point was reached in 1934 and since has been building up until during the fall the situation appeared more alarming for the next year than has been the case for four or more years.

Grasshoppers were about average as to numbers over the whole state during the fall. The numbers were more numerous than last year, but not numerous enough to do important damage except to fall-sown alfalfa and wheat. In many sections in northeastern Kansas fall-sown alfalfa suffered severely the greater part of September. The destruction of one or two drill widths around fields was common. The species rank as follows in the eastern

half of the state: Migratory, differential, two-lined, Packard's, a species without common name (*Ageneotettix deorum*), Carolina, (*Hadrotettix trifasciata*) (in western third of state) and the red-legged. The results of the fall survey are shown in figure 3. The second and third species named were observed to have done serious damage to corn in Clay county and were ovipositing on September 18.

Some spectacular grasshopper flights occurred in the state during the late summer and fall, though they could scarcely be called, in most cases, a migration. The hoppers ascended into the air 50 to 100 feet on warm, still, sunshiny days, and "milled around" in fairly compact swarms. After a flight of a few minutes to perhaps an hour the hoppers settled to the ground from whence they had arisen. While the migratory grasshopper was the common

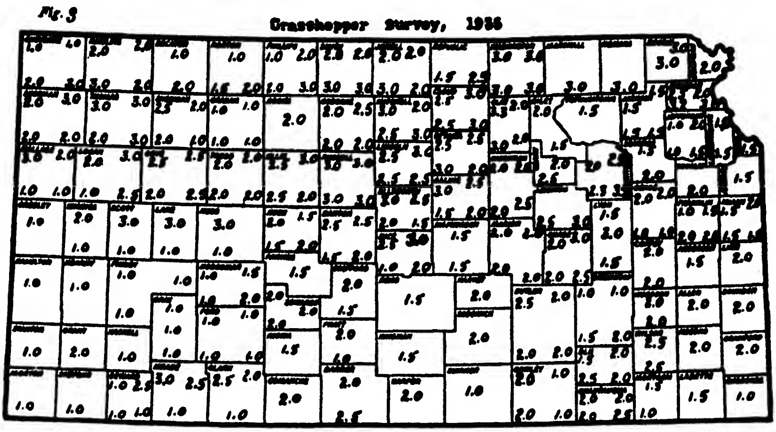

FIG. 3. Grasshopper survey, 1935. (For explanation, see text.)

one indulging in these flights, there were reports of the differential and two-lined species also flying in swarms.

There was a heavy flight of *Pardelophora haldemani* to the lights of the business district of Manhattan on July 13. They occurred in considerable numbers on favorable nights from July 3 to 15. A similar flight was reported at Wakefield July 15. They caused some annoyance around filling stations and on sidewalks near stores.

Large lubber grasshoppers were exceptionally plentiful in Cowley county, according to Charles Burt. They were also numerous in the northwestern counties during 1935.

GREEN CLOVER WORMS were more plentiful in alfalfa fields about the middle of September. As many as 150 larvae of this species were taken in 25 sweeps of a net in alfalfa. There was perceptible foliage damage in some alfalfa fields in Riley county during September. This was the nearest to an outbreak of this species seen in recent years.

HESSIAN FLY was present during the spring, but caused the least damage in the state since 1918, due chiefly to the dry fall of 1933 and the dry spring of 1934. There were several fly reservoirs in Riley county which had about five

percent of the clumps infested in the spring. They were observed to be scarce in Harper, Saline, Kingman, Pratt, Comanche, Ellsworth, and Dickinson counties. However, in Labette, Montgomery, and Barton counties they were readily found. There is a possibility, according to Doctor Painter, that dust from dust storms on the leaves of wheat may have retarded the migration of young larvae from the eggs on the leaves to their feeding places.

Observations in southeastern Kansas the latter part of June indicated that this insect was abundant in the vicinity of Parsons. The area east and south of McPherson county had a heavy infestation during the fall, and spring observations showed that thousands of acres of wheat planted before the fly-free date were severely injured or practically ruined. The fall rains were very favorable to the fly, and the excellent fall stand provided an abundance of plants at the right time and stage for egg deposition.

Leaf Hoppers increased in numbers in alfalfa early in the summer and were numerous by the middle of June. By July 26, 53 percent of the total number of the total alfalfa insects were potato-leaf hoppers. This leaf hopper was common on turnips in Harper county in early May. They were very abundant on potatoes in Harper county. The potatoes dried up early and then the leaf hoppers migrated to the alfalfa and built up rapidly.

The alfalfa yellows disease was particularly noticeable in Riley county during the latter part of July when the second cutting was delayed.

The leaf hopper populations in the following counties were scored at 2: Scott, Cowley, Lyon, Osage, Shawnee, and Marshall. Linn county was rated at 3.

Leaf hoppers attacking apple foliage were exceedingly numerous in apple orchards during August and September. Apple foliage was spotted and scarred more than usual from their feeding. The leaf hoppers flew from apple foliage in clouds when the limbs were jarred. Professor G. A. Dean rated apple-leaf hoppers at 5 in northeastern Kansas. Dr. R. L. Parker observed them biting persons in Riley county.

The Lesser Peach Tree Borer (*Synanthedon pictipes*) caused injury to interplanted peach trees in an orchard in northeastern Kansas in the early spring.

May Beetles came to the lights in Riley county in smaller numbers than usual the last of April because of the cold nights, but they began about May 1 and continued in large numbers until June 15. They were slightly more plentiful than average, but cool nights made them less active until the middle of June. Adults of the small species continued in fair numbers throughout July. White grubs in the soil were somewhat less plentiful than usual in April. May beetles were reported defoliating Chinese elms at Herington (Dickinson county). There was some damage to well-manured lawns and grass plots near street lights in Manhattan during the summer.

The green June beetle was again present in local outbreaks in the extreme eastern part of the state, where damage was done to peaches, plums, and apples. Specimens were sent in from Wyandotte county July 26 (Kansas City, Kan.).

This insect is apparently on the increase in southeastern Kansas.

These green June beetles were erroneously reported as being the Japanese beetle. There was considerable correspondence about it.

Some Miscellaneous Moths and Butterflies

The Painted Lady Butterflies were observed unusually plentiful during May. They appeared to be migrating. Professor Bryson saw 70 adults presumably of this species cross an area 100 feet wide in about 10 minutes.

Larvae were plentiful on thistles in Riley county during early June. Most of the thistle plants in Riley county were more or less riddled by these larvae in June and early July.

The red admiral butterfly was also more plentiful than it was last year.

A notodont larvae attacked some poplars, cottonwoods, Chinese elms, and a few other trees in September in eastern Kansas.

Mourning Cloak Butterfly larvae were more abundant at Manhattan during 1935 than for several years previous. The spiny larvae fed on the foliage of several trees and were plentiful in Scott, Barber, and Leavenworth counties.

The Buckeye or Peacock Butterfly was also very abundant. The chrysalids were taken frequently on buildings. This butterfly was plentiful in Leavenworth, Riley, Reno, Scott, and Barber counties.

The Eight-spotted Forester moth was rated at 3 by Dr. R. L. Parker in Riley county.

The salt-marsh caterpillar was somewhat more plentiful than for several years. It attacked maples at Newton in May.

Mosquitoes (*Aedes* spp.) emerged in great numbers from a vegetation-clogged pool in a rock garden at Manhattan on April 23. They and small gnats were troublesome at Manhattan and Hays in early July. There was a heavy flight of gnats (small chironomids) at lights the night of August 11, 1935.

Equine encephalomyelitis was more prevalent in Kansas than in recent years, according to Dr. H. F. Lienhardt of the Veterinary Division. This disease is mosquito borne, *Aedes vexans,* a common Kansas mosquito, being one of the carriers. Doctor Lienhardt estimated that there were 2,500 cases in the state during 1935, or an average of possibly 20 cases per county.

The Plum Curculio damage was observed on cherries at Manhattan, but the population of this pest was small.

Redbud leaf folder was absent up to early June, after which time it severely attacked the foliage of plants in Riley county. A large first generation was produced and a large second generation attacked the trees during July. It appeared in outbreak proportions in Riley county, and on some bushes every leaf was folded at least once and many had two foldings. The third generation damaged the trees in early August.

Mr. P. G. Lamerson reported the second brood of the Strawberry Leaf Rollers as being very small. They developed later than last year. No damage occurred from either the first or second broods. Some damage was reported the last of June to a three-acre strawberry patch near Valley Center.

In December a heavy infestation of Elm Scale (*Chionaspis americana*) was discovered in Medicine Lodge, Kan.

The Cedar Scale was reported abundant at Hays, Kan., in June.

Scotogramma trifolii larvae were exceptionally plentiful during May and June in Riley county. They were also taken from potatoes in July.

These larvae developed in local outbreaks in wheat fields during September.

The larvae varied greatly in coloration from black larvae with four longitudinal thin yellow lines to very light green and gray. The damage was first thought to be due to white grubs or false wire worms, but these larvae live all the time above ground. They were reported from central Kansas chiefly. This insect was abundant, however, in western Kansas all summer, as Mr. H. H. Walkden found that 95 percent of the noctuids taken in the light trap at Garden City during the summer were of this species. The larvae presumably fed on beets.

Seed, especially kafir and corn, held over from 1933 was very heavily infested during the spring with the usual *stored grain insects,* especially angumois grain moth.

The COMMON STALK BORER was reported doing local injury to corn at Lebanon in July.

The STRIPED CUCUMBER BEETLES were plentiful by middle July and caused considerable damage to late squashes and melons. Early planted cucumbers escaped injury. Damage was reported from Herington, Council Grove, Muscotah, Lincoln, and Manhattan. Insufficient rainfall and high temperatures retarded the plants and contributed to injury by the beetles.

SQUASH BUGS were destructive to late squashes and pumpkins in Riley county during August and September. These plants were fewer than usual during the dry, hot summer and the large population of bugs concentrated on them.

TARNISHED PLANT BUGS appeared in alfalfa fields in normal numbers in early June. The first generation matured about June 12. The second generation matured about July 17. It was a large brood and the alfalfa fields were heavily infested. Considerable damage, which was intensified by the hot, dry weather in July, was done to the blossoms.

TERMITES continued to be the subject of increasing correspondence over the state. Letters continued during July, the hottest part of the summer, at the rate of one to three per day. The first swarm at Manhattan occurred February 21. There was much termite activity in Riley county during May. Several damaged buildings and termite infestations were observed in Ellsworth and Barton counties.

Termites were swarming in Crawford, Neosho, Saline, and Labette counties April 16 to 18. Workers were readily found in gardens and around dwellings. The infestation of farm buildings in Saline, Ellsworth, Barton, Rice, and Russell counties was noted to be surprisingly large. Injury to roofs was especially common. Some carpenters are beginning to take termites seriously, though this is not generally the case.

There has been a marked increase in the number of houses treated by firms and individuals and increased interest in constructing termite-proof buildings.

TOMATO HORN WORMS and the WHITE-LINED SPHINX larvae were more plentiful than average during September in Riley county. Many tomato plants were defoliated by horn worms. These insects were abundant in Smith county in September.

The larvae of the WHITE-LINED SPHINX was exceptionally plentiful during September in Riley county, where considerable defoliation of four-o'clocks and some other flowers occurred. The moths were more plentiful than usual at petunias.

The Twelve-spotted Cucumber Beetle was not collected in Riley county until June 1. By the last of July it was found to be less plentiful in the state than for the previous ten years, according to Prof. H. R. Bryson. By September the population had built up until they were regarded as being more abundant than last year.

Beet Web Worm Moths (*Loxostege sticticalis*) were very abundant at lights and on grass in Pratt, Comanche, Riley, and Kingman counties during early May. Mr. H. H. Walkden caught six quarts of these moths on the night of May 1 in a local light trap. This was the first favorable night for moth flights. This species caused damage as larvae in alfalfa and beet fields during the later summer.

Beet and alfalfa web worms were taken in larger numbers than usual on lamb's-quarter plants on June 15 in Riley county. The larvae were then mostly fully grown. Many were parasitized with tachinid eggs. During the fall, Professor Wilbur observed that the heavy population of beet web worms in the western two thirds of Kansas which characterized the fall of 1934 had been practically wiped out and only occasional larvae were found. Corn was reported injured the middle of July at Wakarusa by garden web worms.

A large population of garden web worms began to appear in alfalfa in southern Kansas about July 20. The moths were plentiful at lights throughout the latter part of July. No damage was done, however.

Walnut Worms began to appear in numbers in Riley county about the middle of July, and most of the walnut trees were partially or nearly completely defoliated by July 26. The first generation was maturing at that time. The second generation of the walnut and other species of Datana occurred about a month later than usual. Newly hatched and half-grown larvae were taken on the campus September 13. Some were found on the walks and on sumac trees. The late emergence of the second generation is perhaps a temperature or moisture reaction following the dry, hot summer and the abundant rains of the last week of August and early September.

The sumac datana also was common during July at the Country Club, Riley county. Defoliation was about 30 percent.

Dr. R. H. Painter summarizes the population of the wheat stem maggot in the region of Manhattan as having been more abundant than usual. This was apparently due to the crop of culms forming on wheat after the June rains. Many of these late culms were infested.

The Wheat-straw Worm was observed to have done some damage in two out of six fields examined in Harper county on May 8.

Wire Worms were scarcer in the spring at Manhattan than for ten years. They were reported injuring potatoes in a garden at Peru, Kan., in June.

OBSERVATIONS ON ARACHNIDS AND PLANT DISEASES

Mites, Plant and Animal Parasites

Red spiders were exceptionally plentiful and destructive all over the state during July. They appeared on elm foliage, following the aphid outbreak, and hastened the death of some trees. Elms all over the state were more or less severely damaged by them. They killed beans and sweet peas in Riley county by June 15. Hollyhock, columbines, bitter sweet, roses, beans, beets, blackberries, raspberries, Osage oranges, plums, apples, and violets were particularly

affected by the middle of July, though most all fruit, truck and ornamental plants were affected. The outbreak increased in severity during the latter part of July. The very conspicuous damage to foliage of attacked elms appeared yellowish green. A peculiar feature of this year's attack was that arbor vitae and cedars were not attacked, while last year they were the center of the attack. The question arose whether two species or biological races may have been involved.

Red spiders on vegetation had about disappeared by the middle of August or were becoming scarce. Apple seedlings in the Kaw valley had been heavily attacked, but an examination of seedlings on August 14 showed no live mites, but there was much dusty webbing on the foliage. Reports of red spider injury came from Pratt, Kiowa, Russell, Wilmore, and Clifton. The hot, dry weather beginning July 6 continued to August 12. These pests were favored by the absence of dashing rains which would have washed them off.

On August 26 the Kansas City *Times* carried the item that drought and red spider threatened the apple crop of the Arkansas valley.

During September an exceedingly heavy migration of the two-spotted mite occurred from foliage to overwintering quarters in the crevices of bark on elms and to leaves on the ground. The mites migrated down the limbs and trunks of the trees, spinning a silvery web as they went. The yellow mites collected in masses, causing the bark to appear yellow at times. The silvery webbing also attracted attention. A fungus disease developed in the masses of mites and destroyed large numbers of them.

A very striking thing about the migration was that the mites which migrated down during the abnormally hot weather the first part of September, came down predominantly on the north and northeast sides of the trees because this portion of the tree was less exposed to the hot sun. Those migrating during the cool weather came down on the south sides of trees or where the most warmth occurred.

Brown Mites (*Bryobia praetiosa*) were first reported March 23 in a small patch of wheat near Ellsworth. The wheat was showing damage at that time. The mites were located in this same general area during 1934. For the state, brown mites were regarded as having been abundant, though the damage was largely confined to spots in fields where stubble infested in 1934 was left on the surface of the ground. This condition also prevailed in Ottawa, Dickinson (especially the west side), and Saline (on east side). In some cases injury similar to mite injury was caused by dry weather.

Brown mites were injurious on alfalfa in the fall and reduced the alfalfa seed crop in central Kansas. They were observed to have been abundant in Smith to Barber counties in September.

Mange was observed in a herd of hogs in Cloud county, January 3, and by early April the herd was heavily infested.

Spinose Ear Ticks were severe during February in ears of cattle in Logan and Wallace counties. Cattle being examined for warbles were found to be heavily infested with ear ticks. Some infested cattle were taken from Wallace to Ottawa county in 1930 and the descendants of that herd were found to be infested in April of this year.

Chiggers were plentiful in Riley county during July. Lawns, brambles, wheat, and alfalfa fields showed a considerable infestation.

BLACK WIDOW SPIDERS involved about the usual correspondence, though somewhat less than last year.

Wheat was heavily attacked by *red or leaf rust* and *black stem rust* during 1935. By June 15 the straws of some varieties of wheat had the leaves seriously damaged and the yield was materially reduced.

CEDAR APPLES were destroyed in all but southeastern Kansas by the hot weather following spring rains. Apple trees (Jonathan, Wealthy, Rome, Crab, York Imperial and other more susceptible varieties) showed no cedar apple rust on the foliage in July and August which is unusual.

SUMMARY AND CONCLUSIONS

The year 1935 was the fifth year of drought or insufficient rainfall for crops, but the ample supply of moisture from September on gave hope that rainfall was on the increase. The year has been described as having two drought and two flood periods. Serious drought prevailed until the latter part of May, during which there occurred the worst dust storms for generations. During June there were serious floods, causing some loss of life and heavy property damage in eastern and northern Kansas. During July and August excessive temperatures prevailed, with almost complete absence of rain, forming the second drought period of the year. Heavy rains the latter part of August and during September caused floods again in southeastern Kansas. For the year, there was 0.1 inch more than normal rainfall, but it was badly distributed both as to time and localities. The temperature for the year was 1.2 above normal for the state.

The year was characterized by *outbreaks* of the elm leaf aphid, tree borers, especially the flat-headed apple-tree borer, cankerworms, corn-ear worms, biting flies on livestock, screw-worm flies, green clover worms, redbud leaf folder, walnut worms, and of red spiders on elms, garden truck, brambles, and many other shade or fruit trees.

The following insects were *scarce* or almost absent during 1935: corn leaf aphid, box-elder bugs, chinch bugs, and hessian fly except in southeastern Kansas.

The following insects were *less* numerous than during 1934: green bug (*Toxoptera*), pea aphid, blister beetles, codling moth, May beetles, beet, alfalfa and garden web worms, twelve-spotted cucumber beetle, and wire worms.

The following insects were *more* numerous than during 1934: alfalfa caterpillar, tomato aphid, cabbage aphid, apple tree tent caterpillar, cabbage worms, cattle lice (both chewing and sucking), cattle grubs, corn bill bugs, crickets (in houses), army worms, false chinch bugs, false wire worms, fleas (in homes), grasshoppers, potato, apple, and wheat leaf hoppers, painted lady, mourning cloak, and peacock butterflies, eight-spotted forester moth, the salt-marsh caterpillar, clover cut worm (*Scotogramma*), striped cucumber beetle, squash bugs, tarnished plant bugs, tomato horn worms, variegated cut worm, dingy cut worm, and the white-lined sphinx. Brown mites in wheat and spinose ear ticks in cattle were also more numerous than last year.

Eye Muscle Imbalances Among College Students

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Recent reports have shown that the average modern school child has fifteen times as much reading to do as his parents had thirty-six years ago, while the college student's reading has increased about five times in the same period. As a consequence of this increased amount of study, students are being subjected to more conditions involving eye strain, and new problems have been presented to the practitioners and clinicians. The members of the eye profession are now learning that something more than glasses alone is necessary for the correction of what one might term the newer visual deficiencies. Not only must the student see clearly (have 20/20 vision) but he must be able to control the movements of the eyes so they can turn, fix, converge, and focus for long periods at a time on the work that he is doing. Any failure of the eyes to coördinate in such a manner often results in great discomfort, confusion, and inefficiency.

That particular phase of physiological optics dealing with the ocular movements, or muscle balance, is still in its infancy, and at present the writer would estimate that not over 15 percent of the professional men who specialize in the different phases of eye work ever consider it in their examinations. To those few practitioners who are pioneers in the field of muscle balance, the greatest of praise is due. The subject is still so new that it is not yet treated completely in any of our professional schools, for most of the advances have been made either in the clinic or private practice, and not in the academic laboratory.

PURPOSE OF THE EXPERIMENT

The purpose of the tests herein reported was to determine the approximate percentage of muscle imbalances among students, and a few of the younger faculty members, along with the symptoms of such defects; and also to make a comparison of several of the different types of instruments used in measuring such ocular deficiencies.

PROCEDURE

Volunteer students from the zoölogy and comparative-anatomy laboratories were used as subjects in the examinations.

At the beginning of the test the student was given a data sheet with spaces provided for filling in his name, age, sex, etc., followed by a list of symptoms common to most eye defects. Also, information was obtained concerning the illumination conditions under which he did most of his study work.

Following this, the Keystone visual safety test was given with the ophthalmic telebinocular (fig. 1). The data blanks used in this test were those provided with the instrument. These tests include a series of stereoscope cards (see figs. 2, 7) with which it is possible to quickly and accurately determine any condition of suppression, the visual acuity, depth perception ability, lateral and vertical imbalances, fusional ability at far and near points, and ametropic conditions of the subject's eyes.

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The lens system of the ophthalmic telebinocular is so constructed that the oculars compensate for all pupillary distances; and by means of the adjustable slide carrier it is possible to obtain effects simulating a distance all the way from thirteen inches to twenty feet.

Following the Keystone test the positive and negative convergence amplitudes of the subjects were taken by three different methods:

First, with the Keystone jump duction slides.

Second, with the American Optical Company phorometer and a stationary phoria chart (author's construction).

Third, again with the A. O. Phorometer, but with the Arneson revolving disk squint corrector as a target.

The jump ductions consist of two pairs of stereoscope slides. The upper stationary or control pair (set at 0° so the patient's eyes are parallel) contained, in this instance, the right- and left-eye pictures of a ship scene, while the lower pair contained the right- and left-eye pictures of a polar bear.

The subject was asked to concentrate on the lower picture while the slides were moved inward until he saw two complete bears. Next they were moved back to the 0° position and then moved outward away from each other until the patient saw two pictures again. In both cases the position of the cards at the diplopia point—that is, when the subject was no longer able to turn his eyes to follow the pictures and consequently had double vision—gives the positive and negative convergence amplitudes. That is the ability of the eyes to converge or diverge respectively.

Next, the same measurements were determined by having the subject look through the American Optical Company phorometer at a distant verticle white arrow against a black background. This instrument consists of a pair of rotary prisms with a pupillary adjustment for the eyes of each individual subject. Each ocular consists of a pair of 15° prisms mounted so they can be rotated in opposite directions. When set at 0° the bases and apices lie opposite so they neutralize each other; when turned so the bases and apices lie together their strength is addative. The total power when looking through both oculars can be turned up to 60-prism diopters.

This instrument measures the subject's ability to turn the eyes both inward and outward while looking at the distant target (20 feet). Turning the prisms base-out (apex-in) has the same effect as sliding the jump duction slides inward—in both cases the patient's eyes must converge in order to see one picture—thus determining the positive convergence. Turning the prisms base-inward (apex-out) has the same effect as moving the jump duction slides outward, thus determining the negative convergence. In either case the patient's eyes must diverge in order to still see one target.

Following the test with the arrow card, the same strength was determined with the Arneson squint corrector, a revolving-disk type of instrument which makes it possible to determine the relative strengths of the internal and external recti while the eye is in motion.

In addition to the above tests, the subject's visual acuity was determined by means of the Snellen's charts. The size of the pupil was noted, and various other factors, such as color of eyes, transverse wrinkles of the forehead, and conditions of squint, etc., were recorded.

RESULTS

From the results certain points are quite apparent:

1. Out of the group of 100 subjects, 87 of them showed symptoms of eyestrain.
2. Of the group showing conditions of strain, 71 had normal vision.
3. Of this normal vision group, 48 had astigmatism.
4. Varying degrees of suppression were found in 39 of the cases.
5. Only 22 were studying under conditions of adequate illumination.
6. Sixty-six of the subjects had low muscle amplitudes.
7. Out of the 50 subjects who were wearing glasses only four did not have conditions of eye strain.

DISCUSSION

One of the major points of the results is the fact that 78 of the subjects were studying under improper conditions of illumination. Although the optimal amount of illumination varies with the individual, the author recommends for most cases a 100-watt frosted blue daylight bulb for direct-ray desk lamps, or a 150-watt clear daylight blue bulb in lamps of the I. E. S. specifications. By all means, a blue bulb of 100 to 150 watts should be used for study purposes.

As to the relation of 20/20 vision and eyestrain, it is rather remarkable that 75 + percent of the students having normal vision or better had marked symptoms of eyestrain. Also, of this group 55 + percent had astigmatism. Too much emphasis cannot be laid on the fact that many students have been misled by the results of the eye examinations given by nurses, teachers, or athletic instructors. It is not the examiner's fault, particularly, but the result of the widespread belief that if a person's vision is 20/20 or 20/30 they are to be classed as normal and their eyes are believed to be in perfect condition. A similar belief exists that if a pair of glasses gives a person 20/20 vision that is all that is necessary for his eye conditions.

In the cases of muscle balance, only 34 of the students had amplitudes that are considered adequate for perfect eye comfort. Dr. T. J. Arneson of Minneapolis, Minn., a leading authority on the straightening of cross eyes and the study of ocular muscles, has found that a five-to-one ratio must exist between the positive and negative amplitudes in order for the ocular muscles to function properly. Thus, if the negative convergence measures 8, 10, or 12 degrees, the positive should measure 40, 50, or 60 degrees, respectively. These figures are for the usual run of cases where the subject is nearsighted (myopic) or has astigmatism.

In cases of high degrees of farsightedness (hyperopia), a different condition exists, which requires plus lenses for the correction. However, there is a law of physiological optics that a plus lens inhibits convergence. Consequently, in such cases amplitudes which are adequate for nearsighted persons will be insufficient for hyperopic patients. The ratios in such cases must be built up higher, say to + 100, and — 10, so the muscles will be strong enough to counteract the inhibitory effect of the lenses.

The above-mentioned points on muscle balance are well illustrated by three of the subjects during the experiments:

SUBJECT NUMBER 82. Male, age 26. Wearing an Azurelite Blue lens with a correction for astigmatism. Visual acuity, Keystone 105 percent; Snellen's line 10 — OD, OS, OU. His muscle ratios are + 52, + 60, — 10, and — 20. With his lens correction on, his eyes are in perfect condition and he has a record clear of all symptoms.

SUBJECT NUMBER 81. Male, age 27. Very farsighted and wears strong plus spheres for study purposes. Dislikes to wear them all the time, as they blur his distant vision. Visual acuity with Keystone 105 percent, Snellen's line 9 — OD, OS, OU. According to the Keystone test, he showed astigmatism for which his glasses were not corrected. With or without his glasses he still has the following symptoms: Experiences a stinging sensation, eyes become bloodshot, lids smart and burn, eyes tire easily, sensitive to light, falls asleep easily, sees floating spots, and reads slowly.

For a normal case his amplitudes of + 40, + 40, — 8, and — 8, are quite ample. These, however, were taken with his glasses off. While wearing his glasses the ratios were only + 24, + 24, — 8, — 8, or a difference of three to one. This demonstrates very strikingly the effect of plus lenses on the inner recti muscles of the eye. In order for this subject to have perfect eye comfort the muscles must be built up so they can offset the inhibitory effect of the lenses.

In the third case, subject 67. A girl, age 19, who is nearsighted and wears glasses that are supposed to correct her errors of refraction. However, according to the Keystone tests with her glasses on, she still has decided astigmatism, and from the data sheet she has the following symptoms: Has shooting pains in eyeballs and back of neck, lids smart and burn, eyes tire easily, sensitive to light, falls asleep easily, sees floating spots, and reads slowly. She can see better without the glasses than with them, and her muscle balance measures + 24, + 15, — 10, and — 12. Before this subject will ever have any degree of eye comfort, the eyes must be built up by daily office treatment with periodic changes of lenses until the muscle ratios are normal and the final refraction is made.

The results show that even some of the cases with high muscle balance ratios have symptoms of eyestrain. In all such cases, however, there is the condition of astigmatism or a possible hyperopic error, along with inadequate illumination, which is responsible for the eye troubles.

Another point is the number of cases of suppression. Out of the whole group, 39 of the subjects were using only one eye part of the time. Some cases were worse than others, but the percentage was surprisingly high.

CONCLUSIONS

From the results of the above experiment it is quite apparent that the condition of muscle balance is very important, and in the routine eye examinations conducted in the schools, as well as in the clinics and private practice, it should be given more consideration. Greater advances could be made, however, if the work were carried on in the academic laboratories.

It is a disturbing discovery to find that of the subjects who are wearing glasses 92 percent still have marked conditions of eyestrain. This high percentage clearly indicates that the myologic conditions have been greatly neglected.

ACKNOWLEDGMENTS

The writer wishes to make due acknowledgment and to thank Dr. T. J. Arneson, of Minneapolis, Minn., the American Optical Company, branch office at Kansas City, and the Keystone View Company of Meadeville, Pa., for the use of the different optical instruments necessary for the experiment.

FIG. 1. The Ophthalmic Telebinocular, a stereoscope type of instrument for ıpid and accurate diagnosis of refractive and myologic conditions.

VISUAL ACUITY TESTS

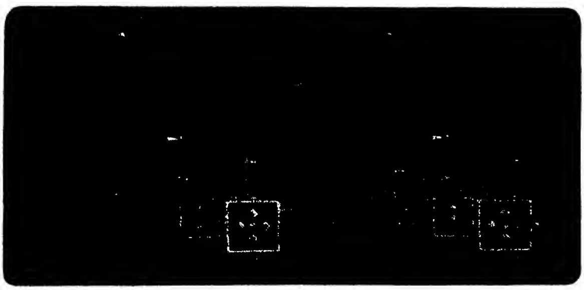

FIG. 2. Slide DB-1

Purpose: To test visual efficiency with both eyes acting together, as habitually.

Normal Performance: A score of 100% (discernment of the dot in the ninth sign) is normal.

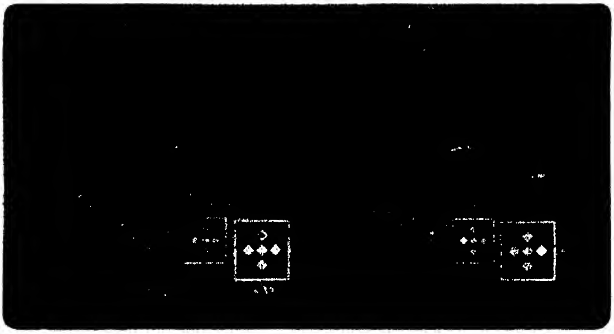

FIG. 3.

Purpose: This slide checks the visual efficiency of the left eye without disturbing by occlusion the habitual binocular coördination.

The right-eye card is similar, but with the dots reversed.

VERTICAL BALANCE TEST

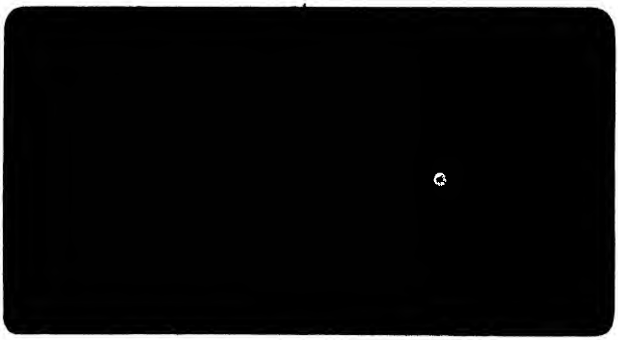

FIG. 4. Slide DB-8

Purpose: This slide determines whether or not the eyes function in the proper horizontal plane.

Normal Performance: One with normal eyes should see the green line projected upon the black dot in the center of the red ball.

With this slide it is possible to detect conditions of suppression. Failure of subject to see either the line or the ball indicates suppression of the left or right eye respectively.

LATERAL IMBALANCE TESTS

FIG. 5. Slide DB-9

Purpose: This slide determines the phoria conditions (tendency of the eyes to deviate in or out). Failure to pass this test when the instrument is set at distances simulating infinity, forty inches, and thirteen inches indicates possible ocular fatigue when viewing objects at those respective distances. At infinity the arrow should point within the numbers of 8 to 12, at forty inches—it should be between 6 and 9, while at thirteen inches the range is from 3 to 6.

TESTS FOR FUSION ABILITY

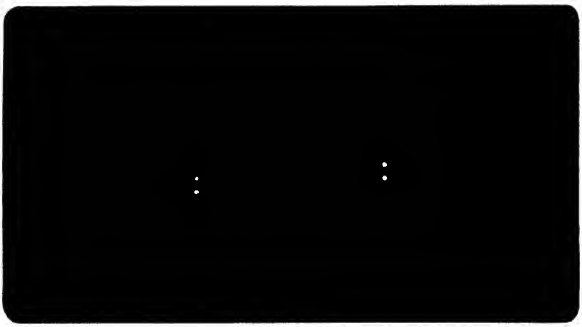

FIG. 6. Slide DB-5

Purpose: To test fusion ability at reading distance. Those who do much close work should be able to pass this test.

Normal Performance: The subject with normal eyes will report three balls instantly.

This slide is also helpful in detecting conditions of suppression. If the subject sees only two balls one of his eyes is suppressing.

TESTS FOR CONDITIONS OF AMETROPIA

Fig. 7. Slide DB-7

Purpose: This slide detects errors of focus of a degree sufficient to interfere with efficient vision. Two tests are taken with this slide; one at 3.00—13 which detects inefficiency when looking at objects within arm's reach, such as reading, inspecting, etc. The other test is at 00—∞ which detects inefficiency when looking at objects beyond arm's reach.

Normal Performance: The subject with normal eyes should see three black lines in each of the twelve balls with the slide holder at 3.00—13 or at 00—∞, or at any place between these two positions.

A Comparative Study of Character and Conduct Among Scouts and Nonscouts in El Dorado, Kan.[1]

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INTRODUCTION

The few studies made on the general subject of character and conduct to date have failed to produce much evidence in favor of scouting as an effective agency for moral education.

This investigation represented an effort to compare the character and conduct of scouts with that of nonscouts of equal mental ability in the same school. An attempt was made to answer these two questions:

1. Do boys with scout training possess a greater amount of moral information than do boys of equal mental ability who have not had training in scouting?

2. Do scouts or nonscouts manifest better character and exhibit better conduct as these are measured by standard tests and rating devices?

PROCEDURE

The subjects used in this experiment were 158 boys, all of whom were enrolled in the public schools of El Dorado, Kan. Of the 158 boys 130 were in the junior high school, 23 in the senior high school, and 5 in the junior college.

At the time the investigation was started there were in the three schools approximately 100 active boy scouts who had been registered six months or longer.

The intelligence quotients of these boys were obtained, along with their ages and year in school. Using the same kind of intelligence tests, a parallel group of nonscouts was selected. Special effort was made to match each scout with another boy (nonscout) with the same I. Q. of the same age, in the same grade, and with the same socio-economic background.

Because of the inability to find nonmembers to match a few of the outstanding scouts, and because of the failure of some of both groups to complete all of the tests, the number included in the experiment was finally reduced to 79 nonscouts and 79 scouts.

For equating the groups on the basis of intelligence "The Otis Group Intelligence Scale, Advanced Examination, Form B," published in 1929, was chosen.

The mean I. Q. for the scout group was found to be 113.006 as compared with 112.807 for the nonscout group. That this represented no appreciable difference in ability was indicated by the fact that the difference was only .145. Accepting a critical ratio of three as indicative of a true differenece, it would be seen that this value (.145) was well below that required for complete reliability. Apparently, the two groups were nearly equal in intellectual capacity.

The mean age of the nonscout group was 14.203 years and of the scout group 14.275 years.

Trans. Kansas Acad. Sci. 39, 1936.

1. A condensation of a thesis submitted to the graduate division of Kansas State Teachers College of Pittsburg, Kan., in partial fulfillment of the requirements of the degree of Master of Science.

The first comparison of the two groups made was with regard to school marks.

The results of the scholarship ranking based on evaluated school marks given over a period of a year showed a mean of 6.671 for the scout group as compared with 5.582 for the nonscout group. The difference over the standard error of difference was 2.833. This critical ratio indicates that there were 99.74 chances in 100 that this represented a true difference. On the basis of this evidence, the group of scouts, although of approximately the same intelligence as the nonscouts, appeared to achieve on a distinctly higher level in school work than did nonscouts.

As a measure of moral knowledge of members of either group, "Form I of the Moral Information Test," developed in connection with the character education inquiry series of character and personality tests, was used. This test consisted of four subtests: (*a*) The Cause-Effect Test, (*b*) The Recognition Test, (*c*) The Social-Ethical Vocabulary, and (*d*) The Free Response Foresight Test.

The mean of the scores of the scouts on this test was 143.481 and that of the scores of the nonscouts 135.506. The difference between these two means, divided by the standard error of difference, was 2.103. This ratio indicated that there were 98 chances in 100 of this being a true difference. Apparently the scouts as a group knew more than the nonscouts about what is right and what is wrong.

Reputation measures were then applied to determine how the subjects stood among their fellows and among their teachers.

It was thought that when the reputation of pupils with their teachers was combined with their reputation among one another that such prejudice as the adults and the boys do not share would tend to balance each other and the total reputation be more nearly representative of the truth. And as the makers of the test conclude, "prejudice is itself a significant social fact and needs to be known, no matter how far from the truth it may be."

The scores of the groups on the "Guess Who Test" ranged from a (—27) to (+60) for the scouts, and from a (—60) to (+33) for the nonscouts. The mean score for the scout group was 5.285 and for the nonscout group 1.563. The standard deviation for the scouts was 15.410 and for the nonscouts 12.380. The standard error of difference was 2.222. The difference over the standard error of difference (1.941) was probably indicative of a fairly high reliable difference. Statistically this ratio represented 97 chances in 100 of there being a true difference between these groups on the basis of reputation.

The "Teacher-Pupil Rating Test" developed by Kelley and Trabue was used as sort of a check against the "Guess Who Test." This was a device used by these men in their study of the free association test for measuring character. The subjects were rated on the following eight traits, by three teachers, who sometime or other had taught all of the boys: 1, Courtesy; 2, Loyalty to his fellows; 3, Poise; 4, Fair play; 5, School drive; 6, Regard for property rights; 7, Honesty in school work; 8, Mastery.

The results of this test showed that thirty-four different scouts and sixteen nonscouts were named by the three teachers as having a great amount of one or more of the eight positive traits. The evaluated scores of these thirty-four scouts totaled 809 as compared with 359 for the sixteen nonscouts.

Twenty-one nonscouts and eighteen scouts were listed by the teachers as possessing the negative traits to a high degree. The total of the evaluated scores of the nonscouts group on the negative traits was 617 and that of the scouts 247. The average evaluated score for the eighteen scouts was 13.722 and that for the twenty-one nonscouts was 29.580.

Another reputation measure quite similar in description and form to the "Guess Who Test," known as the "Who Is It Test," was used.

The results of this test were very much in accord with those of the "Guess Who Test." The individual scores ranged from (—30) to (+27) for the nonscouts and from (—25) to (+45) for the scout group. The mean score for the scout group was 5.285 and for the nonscout group 0.222. The standard deviation was 13.577 for the scouts and 9.132 for the nonscouts. The difference over the standard error of difference was 2.751. Here again there seemed to have been a highly reliable difference in favor of the scout group. The critical ratio of 2.751 indicated that there were 99.8 chances in 100 that there was a true difference between the two groups with respect to the traits considered.

The test results considered and reported thus far represent, besides achievement, the judgments of the members of either group relative to other members of their own group or of members of the other group. The next measure used was one which represented judgment of self on character and conduct, known as a "Character-Conduct Self-Rating Scale for Students," by Edwin J. Brown. The scale was designed for rating one's self on ten traits, namely, punctuality, obedience, honesty, courtesy, coöperation, industry, fair play, good health, self-control, and service.

The mean score for the self-rating of the nonscouts on the basis of 100 was 63.196 and for the scouts it was 67.057. The standard deviation for the nonscout group was 12.609 and for the scouts it was 11.992. The difference over the standard error of difference was 1.757. This indicated that in 96 chances in 100 there was a true difference in the self-rating of the members of these two groups. The self-ratings of the subjects when checked by their home-room teachers were changed but very little. The mean of the teacher ratings scores was 67.690 for the scouts and 64.146 for the nonscouts. This stands as further evidence that the scout group possessed to a higher degree the traits considered.

For the final test an objective measure of conduct was used. This test, known as the "Athletic Contest, Series B," was developed in connection with the Character Education Inquiry Series of Character and Personality Test. It was a combination physical ability-honesty test used by Hartshorne and May to measure deceptive behavior in athletics.

There were four parts to the test: (*a*) Hand grip, using hand dynamometer; (*b*) Lung capacity, using spirometer; (*c*) Pull-up or chinning; (*d*) Broad jump. Because of the experimenters' inability to procure a dynamometer this study included the use of b, c, and d only.

Cheating was effected by faking one's record when working without supervision. In the spirometer test there were five scouts whose own marks exceeded the examiner's mark by twenty-five cubic inches or more, indicating cheating, and there were nine nonscouts whose self-markings exceeded those of the examiner by twenty-five cubic inches or more.

In the case of the pull-up there were four instances of cheating on the part of nonscouts and none on the part of the scouts.

There were no records of cheating in the broad jump in either group. Probably because the subjects were too carefully supervised, and hence had no opportunity to cheat, even if they had felt so disposed.

SUMMARY AND CONCLUSIONS

Seventy-nine boy scouts, representing 10 percent of the combined male enrollment of the junior and senior high schools and the junior college of the public schools in El Dorado, Kan., were matched with an equal number of individuals who were not scouts from the same schools, for this study. The two groups were equated on the basis of age, grade in school, and intelligence as measured by the Otis Group Intelligence Scale, Advanced Examination, Form B. These two groups of boys were thus compared with reference to character and conduct in an effort to arrive at some conclusions regarding the effectiveness of the organization as a character-building agency. (Table I.)

For determining whether or not boys with scout training manifest better character and exhibit better conduct than boys of equal mental ability without scout training, a number of character-conduct measures were applied. As reputation is measured by one's fellows, the "Guess Who" and the "Who Is It" tests were used. The results of these tests were treated statistically for reliability differences. To obtain judgment of others a teachers' rating device was used. Then, to get the individual subject's opinion of his own character and conduct, a self-rating scale was employed, checked by each boy's home-room teacher. The only objective measure of conduct used was the athletic contest (combination physical ability and honesty test).

A study of these results relative to the character and conduct of scouts and nonscouts in El Dorado, Kan., led to the following conclusions:

1. As shown by school marks, scouts achieve better in school than do nonscouts.
2. Boys with scout training probably possess more moral information than do boys without scout training.
3. Boy scouts have better reputations for character and good conduct than do boys not belonging to the organization.
4. Under controlled conditions where concrete acts in specific situations are judged, scouts prove more honest than nonscouts.

SUGGESTIONS

The ten-year program in scouting seeks to have one boy in four a four-year trained scout. What a fine contribution in citizenship this would be, having a fourth of our boys, four-year trained scouts by the time they reached voting age, provided, of course, they have lived and practiced the scout oath and law.

However, concentration upon numbers alone would not bring to pass the fulfillment of the entire plan or ideal of the originators of this splendid idea.

The study just concluded has revealed most clearly to the writer the real importance of quality in leadership. Whether or not the program of scouting is effective in building character and in training for citizenship depends

largely upon the type of leadership it engages. The related studies reviewed in this investigation bear further evidence in support of this statement.

There is a need for a study of the status of volunteer leaders in this great movement, and out of such a study there might grow a plan for setting up minimum requirements for future leaders. The fact that the service is volunteered need not be a bar to the setting of such requirements.

TABLE I.—Summary of the different measures as applied to scouts and nonscouts including range, mean, standard deviation, the standard error of differences and the difference divided by the standard error of difference.

Test.	Group.	Range.	Mean.	S. D.	σDiff.	$\frac{D}{\sigma \text{Diff.}}$
I. Q. scores	S	83–130	113.006	8.70	1.307	.145
I. Q. scores	N	88–127	112.817	7.707		
Scholarship marks	S	0–11	6.67	2.324	.384	2.833
Scholarship marks	N	0–11	5.582	2.504		
Moral information	S	70–220	143.481	24.909	3.795	2.103
Moral information	N	84–182	135.506	22.720		
Guess who	S	(—27) (+60)	5.855	15.410	2.224	1.931
Guess who	N	(—60) (+33)	1.563	12.380		
Who is it	S	(—25) (+45)	5.285	13.577	1.840	2.751
Who is it	N	(—30) (+27)	0.222	9.132		
Char.-con. self	S	40.6–93.2	67.057	11.992	2.197	1.757
Char.-con. self	N	31.4–97.2	63.196	12.609		
Char.-con. teachers	S	27.2–92.8	67.690	12.204	2.056	1.723
Char.-con. teachers	N	22.8–97.8	64.146	13.611		
Age	S	12–19	14–279	1.49		
Age	N	12–19	14–203	1.57		

		Number named.		Evaluated scores.	
		Positive.	Negative	Positive.	Negative.
Teachers rating	S	34	18	809	247
Teachers rating	N	16	21	359	617

		Number of instances of cheating.	
		Spirometer.	Pull-up.
Athletic-honesty	S	5	0
Athletic-honesty	N	9	2

Taste Differences in a Family

S. L. LOEWEN, Sterling College, Sterling, Kan.

Ever since the discovery of taste differences in different individuals made by Dr. Arthur L. Fox, of the laboratories of du Pont de Nemours Company, and published in *Science News Letter,* April 18, 1931, a great deal of interest in these physiological reactions has been manifest. One reason for this popularity is the fact that taste differences are inherited. According to Snyder, who used para-ethoxy-phenyl-thio-urea, the taste deficiency behaves as a simple Mendelian recessive character. His results show that 68.5 percent are tasters and 31.5 percent nontasters, and when neither parent could taste the substance none of the children could taste it. Blakeslee and Fox used phenyl-thio-carbamide and reported similar results. At the New Orleans meeting of the American Association for the Advancement of Science in 1931-'32 they tested 2,550 individuals; of these, 28 percent were nontasters, 65.5 percent tasted bitter, 2.3 percent tasted sour and 4.2 percent tasted some other flavor.

The writer, coming from a large family, was interested in determining the occurrence and nature of taste differences and its mode of inheritance in his own immediate family. Of the 101 individuals in the family, including the in-laws, 84 were in a position to participate in the test; these included the parents I, the F_1 (II) and F_2 (III) generations. None in generation IV were old enough to make the test. The American Genetic Association was kind enough to furnish the phenyl-thio-carbamide in the form of treated paper for the test. The testee was not prejudiced or influenced by describing the flavor beforehand, and thus even the children of five years were able to say without hesitancy, and I believe with a high degree of accuracy, as to the taste of the paper.

The results of the test are given in the chart. The percentage of tasters and nontasters agrees fairly well with the results of other workers. Of the total number that were tested, 52 (61.9%) tasted bitter, 31 (36.9%) were nontasters, and one (1.2%) tasted sour. Of the direct descendants of the parents, 37 (57.0%) tasted bitter, 27 (41.5%) were nontasters and one (1.5%) tasted sour, a slightly higher percentage of nontasters than in the above category.

Of interest in this connection is the one case tasting sour. Blakeslee and Fox found 2.3 percent of individuals tested at New Orleans that gave a sour reaction to phenyl-thio-carbamide. At the present nothing is known about the inheritance of this tasting quality.

In the II generation eight have a taste deficiency and four are tasters. This makes it clear that the parent tasting bitter is heterozygous for bitter, as is also indicated by the fact that a sister and a brother tested were nontasters. The eight that are nontasters are homozygous, whereas the four that tasted bitter (C_1, H_1, J_1, and K_1) are all heterozygous for bitter. Again the results in III indicate that the parents A_2, B_2, F_2, G_2, I_2, and L_2 appear to be heterozygous, while C_2, D_2, and H_2, who are sisters, and J_2 and K_2 all seem to be

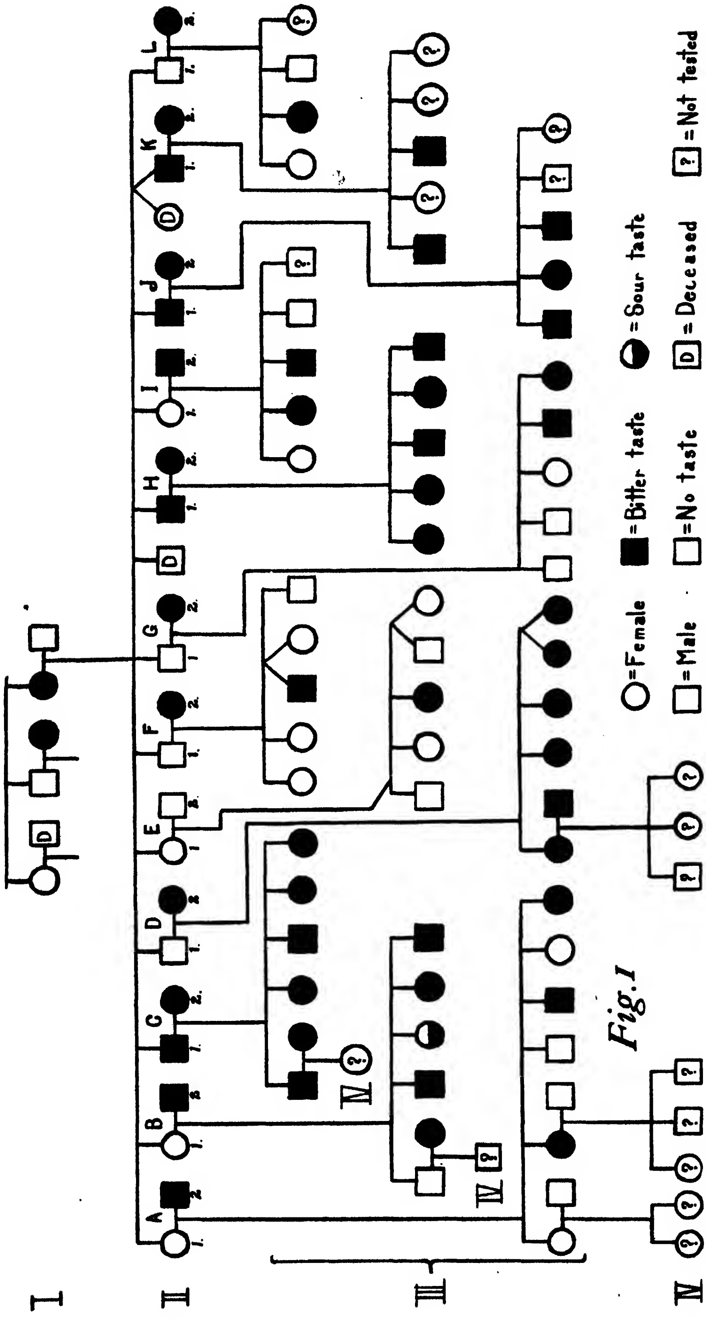
○ = Female
□ = Male
■ = Bitter taste
□ = No taste
◐ = Sour taste
D = Deceased
? = Not tested
I
II
III
IV
A
B
C
D
E
F
G
H
I
J
K
L

Fig. I

pure for bitter. It is possible that B_2 is also homozygous for bitter since he is a brother to C_2, D_2, and H_2, and that the one person in their family indicated as a nontaster might have a very high threshold for bitter taste and thus was not detected. Both C_1 and H_1 seem to have a high threshold, for they detected a slight bitter taste only after chewing the paper for some time. Others experienced an extreme bitter taste immediately upon taking the paper into the mouth. That the ability to taste bitter varies a good deal has already been indicated by Blakeslee and Fox. They maintain that the intensity of sensation experienced by those that taste bitter is independent of the threshold.

Another interesting case for consideration is the occurrence of a bitter taster in family E where both of the parents are nontasters. This should not occur if the character for nontasting behaves in the orthodox fashion of a single recessive gene. Snyder did not observe any such cases in his study, but Dr. R. C. Cook, editor of the *Journal of Heredity,* in a letter to the writer states that several cases of this type have recently come to light. He says that there might be a modifying gene present in connection with the single recessive gene which might be responsible for such behavior. The mode of inheritance of this peculiarity is unknown at the present.

The inheritance of taste deficiency is not limited by age or sex, as Snyder has already pointed out. The distribution of taste differences with regard to sex among the direct descendants in the family reported here is shown in the following table:

	Females.				Males.			Total.
	Bitter.	No taste.	Sour.	?	Bitter.	No taste.	?	
II.......	....	4	....	......	4	4	......	12
III.......	19	10	1	5	14	9	2	60
IV.......	....	....	....	6	....	....	4	10

It is clear from this test that the taste deficiency for phenyl-thio-carbamide is inherited as a simple recessive gene. With the exception of the sour-tasting individual and the one tasting bitter in the family of nontasters, this family record is not unusual as to taste differences of phenyl-thio-carbamide. It is hoped that this test can be repeated and extended in the family sometime in the future with another generation added, when some light on these exceptional cases might be gotten.

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Kansas Meteorites Since 1925

H. H. NININGER, Denver, Colo.

The plains of Kansas have long been famous for their yield of meteorites. As early as 1909 the list of meteorites described from Kansas had grown to fifteen.[1] The period between 1909 and 1923 was one of little activity in meteorites in Kansas, as well as in many other states. Only one find was recorded for the state during this 14-year period; namely, the Cullison stone from Pratt county, which was discovered in 1911.

In 1923 the writer began a search for meteorites in Kansas, which has been more or less constant ever since. Some of the results of the first few years of the search have been described in papers by the writer which have been published in various journals. They include the Coldwater aerolite, 1924; the Coldwater siderite, 1923; the Covert aerolite, 1929, and the Beardsley fall of October 15, 1929. Although during the last five years the search has been pushed quite as vigorously in some of the other western states as it has in Kansas, the work in Kansas is by no means considered complete, and no single year has ever yielded more of the celestial fruit than has 1935. Following is a list of discoveries within the state which have been recorded by the Nininger Laboratory since 1932, when the Beardsley meteorite was described.

THE NEW ALMELO AEROLITE

This find was first definitely recognized as a meteorite when Mr. Alex Richards, representing the Nininger Laboratory, was shown a seven-pound stone by its owner, Mr. Nick Dellere, who had for a number of years preserved it as a curio. The stone, which had evidently fallen some years before it was found, was in a fair state of preservation, being for the most part covered with the original fusion crust. This crust was stained to a rusty brown throughout and where broken from the stone at a few places revealed that the stone's interior was very largely stained to the same color as was the crust.

The form of the stone was roughly that of a rectangular block and showed very little pitting. There was no evidence of an oriented flight. The indications were that it was a fragment produced by the fracture of a larger mass during its passage through the atmosphere.

Cutting revealed that the stone was of a coarse, chondritic structure, bearing a rather sparse and uneven distribution of metallic grains of variable size and irregular form. Sulfide was more evenly distributed in very fine particles, for the most part, though occasionally inclusions of as much as 3 mm. in diameter were found.

The stone evidenced brecciation, apparently having been formed by the assemblage of several fragments of irregular form and of different sizes. All of the different components were made up mainly of chondrules; but one type, which appeared somewhat lighter colored than the rest, showed the chondrules less firmly anchored in the ground mass. These areas did not

Trans. Kansas Acad. Sci. 39, 1936.

1. Farrington, O. C.—Catalog of Meteorites of North America. National Acad. Sci. Memoirs, vol. 13.

polish well, as the ground mass tended to crumble away in the form of powder. It was in these areas where the more abundant distribution of metallic grains was in evidence.

The chondrules, while predominantly round, were in some cases oval or oblong in section and some were found of irregular form. The petrography of the stone is left for later study.

Veins of the usual type ramify throughout the body of the stone, though none stand out large and conspicuous as is the case with many aerolites.

Subsequent to the finding of the first stone, a second one of smaller size was reported. This one is said to have been kept as a curio in the family for about fifty years. It appears quite similar to the first, save for its shape and size. Its weight is 1,130 grams. It is still preserved intact.

THE ULYSSES AEROLITE

About the year 1927 Mr. L. P. Carter picked up an odd-looking stone approximately five miles southeast of Ulysses, Grant county, Kansas. The stone, with other curios, was kept by him until death, when it passed into the hands of his son, Mr. Charles Carter. In 1932 a sample of this stone was sent to the Nininger Laboratory for testing and was identified at once as a stony meteorite containing an unusually heavy content of metallic grains. Subsequently the stone was purchased by the Nininger Laboratory. It was found to weigh 8.5 pounds and was almost a complete individual. The stone was in an excellent state of preservation and appeared to belong to a comparatively recent fall.

A section was cut and sent to the U. S. National Museum. The polished section revealed that the stone is chondritic, though not conspicuously so as viewed by the unaided eye. However, if viewed under a ten-power lens it is seen to be made up almost entirely of chondrules of varying size and appearance. The largest found on the section examined was oval in form and measured 4 mm. in its greatest diameter. The metallic grains are of almost uniform size and very abundant. In some places a considerable aggregation of them are confluent, forming a miniature reticulum, resembling in these small areas the metallic components of the lithosiderites. The grains are very irregular in form and are intermingled with about an equal number of troilite particles which are more variable as to size. The general color of the interior of the Ulysses meteorite is a dark brown and reminds one of the McKinney, Tex., stone. The principal mass of the stone is preserved in the Nininger collection.

THE OBERLIN AEROLITE

In 1929 Miss Sarah Woolley, a rural school teacher of Decatur county, told of a small meteorite which had been found by her brother and kept as a handy weight in their home. When this stone arrived at the laboratory it appeared quite fresh and well preserved as if it had been picked up as a fresh fall. Inquiry into its history revealed that young Woolley had been plowing in a field the day before a rainstorm. Next day he picked up this stone, which he thought had fallen during the night. As stated above, the appearance of the stone is in harmony with this opinion; but of course the evidence is inadequate to justify any definite conclusion in the matter.

The stone weighed 2,800 grams as it arrived at the laboratory. (Figure 1.)

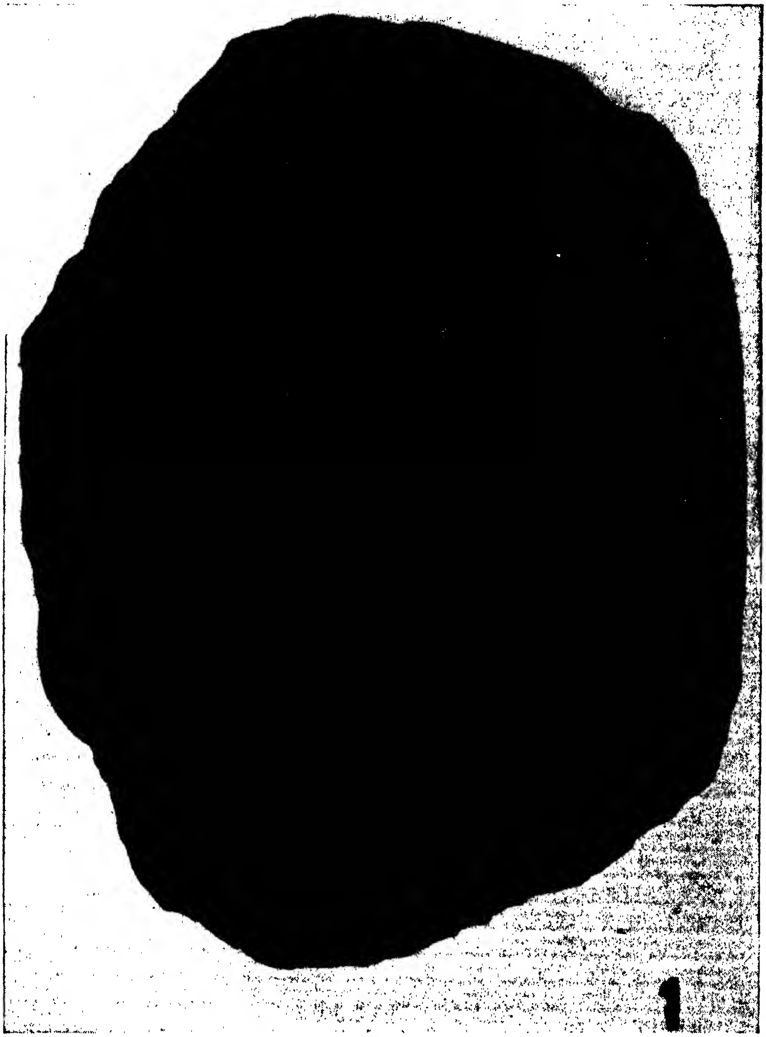

FIG. 1. The Oberlin aerolite as received by the Nininger Laboratory.

It was complete except that numerous small chips had been broken off by rough handling. The stone was very heavily pitted, the pits being of small size and consisting of very abrupt depressions less than a centimeter in diameter for the most part. Many had a diameter of less than 5 mm. The narrow ridges which separated these pits had yielded readily to blows during the years it was kept about the house. This had brought about the chipped surface above mentioned.

The interior of the stone is of a rather light grey color except for rust stains about the metallic inclusions and the bronze-colored troilite inclusions which are abundant and which vary greatly in size. One was revealed in a section which measures 7 mm. in diameter. The nickel-iron grains are relatively scarce and of small size. The stone is very chondritic and shows unusual variations in the appearance of the chondrules under a ten-power lens. The more exhaustive study of the petrographical features of the stone is reserved for some future time.

The meteorite is for the most part preserved in the Nininger collection.

THE PLEASANTON AEROLITE

Only brief mention will be made of this meteorite, which we are informed is preserved in the State Teachers' College at Pittsburg, Kan. A small sample of about 25 grams was sent to the writer for identification by Dr. Abernathy of the geology department of that institution. The sample resembled somewhat the Elm Creek meteorite, but more closely approached in appearance the Bluff, Fayette county, Tex., meteorite. The stone is said to weigh 16 or 18 pounds.[2]

THE SENECA AEROLITE

Recently two stones were received at the Colorado Museum of Natural History from Mr. F. E. Mindrup, who had found them while working in a cornfield near Seneca, Nemaha county, Kansas. The stones were both fragmentary and are said to have been found near together. They appear to have been derived from the same mass.

A laboratory test readily demonstrated that the material was meteoritic. It consists almost entirely of chondrules, with a rather sparse sprinkling of nickel-iron grains. The stones have evidently lain on the earth for a very long time, as the fusion crust has become deeply stained to a dark reddish-brown and in many places has been replaced by a scale of oxide. The interior is also deeply stained throughout. However, the structure of the meteorite is such as to invite careful study, which will be given it as soon as time permits.

THE GRETNA AEROLITE

In 1933 a small fragment was received by the Nininger laboratory from Mr. George Sternberg, with the request that it be tested for meteorite characters. It was found to be of meteoritic origin and appeared to differ from all recorded Kansas meteorites. Mr. Sternberg reported that the fragment had been taken from a mass of "about 80 pounds," which had been found some 12 miles north of Gretna, Phillips county, Kansas. The mass was said to have come from a much larger stone which had been found in a pasture of native grass about 1915. The large stone had been broken and divided up by its finders, and thus was destroyed what had evidently been a very fine aerolite, which must have ranked as the third largest aerolite that had been found within the state up to that time.

Subsequently Mr. Sternberg located a second fragment weighing nearly 50 pounds which was found to fit on the first. When set together a gap was left, indicating the loss of a third fragment about the same size as the second.

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2. The stone has later been examined by the writer and found to weigh $5^1/_{16}$ pounds. Apparently 200 to 300 grams had been removed.

Apparently the stone had been complete and in a fair state of preservation when found. The fusion crust was still well preserved, though badly discolored, on the two fragments recovered. The stone shows some mild pitting.

The interior of the stone is of a coarse texture and does not take a good polish. It is far from being a handsome specimen interiorly. Metallic grains are scattered sparsely and irregularly through a matrix which is deeply stained by the products of alteration in the vicinity of the larger metallic grains. Sulfide is present in about the same abundance as the nickel-iron grains. Chondrules of variable size and color appear throughout the matrix, but are not abundant.

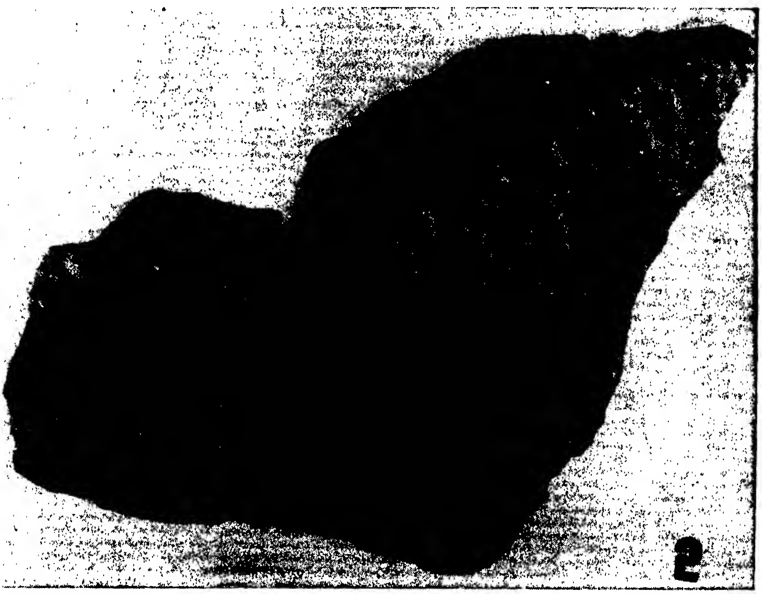

FIG. 2. The close-up of the four largest fragments in the Long Island meteorite, showing the extensive pitting in the part buried beneath the surface of the ground. (Courtesy of the Field Museum of Natural History.)

The larger of the two masses is in the United States National Museum. The second fragment is preserved in the Sternberg collection in the Fort Hays State College at Hays, Kan. A specimen of 500 grams is in the Nininger collection.

TWO GREAT AEROLITES

The finding of large stony meteorites has been of very rare occurrence. Up to the present, only six individuals of weights greater than 500 pounds have been recorded for the entire world. Of these, two were witnessed falls and would almost certainly have never been discovered but for that fact.

It is interesting to note that the remaining four specimens, each of which weigh more than 600 pounds, were all found on the great plains of the west central United States; three of them in western Kansas. The Estacado stone (weight, 640 pounds) was found in 1883 on the level plains of northern Texas, about half buried, on a low ridge bordering a small prairie lake.

Fig 3 The Long Island meteorite collected by Dr J T Willard, 1892 This is the largest stony meteorite ever discovered of the 3,050 pieces recovered is 1,275 pounds (Photograph by J T Willard, in 1892)

The total weight

The Long Island stone, found near Long Island, Phillips county, Kansas, is the heaviest of all on record, but was not found intact. When found by Dr. J. T. Willard[3] in October, 1892, its many smaller fragments lay buried within a foot of the surface of the ground in a narrow strip about twenty feet long, down a slope from the main mass. The four largest fragments were in contact in the ground, but because of fracture seams, separated on excavation. (Fig. 2.) When found the main mass projected about six inches above the ground, the broken surface being up, and the pitted surfaces being under the ground. The five largest pieces weighed 408.5, 264.5, 242, 89.5, and 72 pounds, respectively. Six more weighed 70.5; an additional six weighed 66.5, while all the pieces found, 4,050 in number, weighed 1,275 pounds. (Figure 3.)

The two remaining large aerolites are described in this paper. In the writer's opinion the following factors account for the concentration of these large aerolite discoveries:

1. It is an arid region where meteorites disintegrate less rapidly than in most climates.

2. It is an area where much of the land is under cultivation.

3. There are comparatively few terrestrial rocks in the region. This would render meteorites more likely to attract attention.

These large stones were all found on or near the surface. According to the records we have of witnessed falls, stones of this size should have buried themselves to depths of from eight to twelve feet. This leads to the statement of the fourth factor.

4. This area is a region of aeolian degradation and probably has been for a long time. The gradual lowering of the surface level by this means has brought it down to the point where these stones were exposed either above the surface or within reach of the plow.

5. In Western Kansas a great deal of effort has been put forth by the Nininger Laboratory in an effort to instruct the populace as to the recognition of meteorites. Probably similar finds would be made in other suitable localities if a comparable effort were put forth.

THE HUGOTON STONE

This stone was first encountered by the plow in 1927 when Mr. J. D. Lynch was breaking his land. A fragment of about sixteen pounds was torn up by the plow. The piece was hauled out to the edge of the field and discarded. No interest was shown in the encounter save by way of complaint at its damage to the plow. Each plowing thereafter probably brought up new small fragments; but Mr. Lynch only remembers the grating of fragments on his share. Apparently all memory of the offender had been lost until the writer lectured on the subject of meteorites in the Hugoton high school.

When J. D. Lynch, Jr., had examined an exhibit of meteorites in connection with the lectures, he recalled the stone which lay under the fence at the edge of their field and noted its resemblance to a specimen in the exhibit. This being reported, the writer went with young Lynch to where the stone lay half buried under the fence, and found it to be truly meteoritic. The writer also noted that it was only a fragment of a larger mass. A search was at once

3. Information furnished by Doctor Willard. (For further description: See Nat. Acad. Sci. Memoirs, 18:277-284.)

instituted in the locality where the stone had been plowed out (about three eighths of a mile from where the fragment was examined). By noting the distribution of small chips in the soil, the parent mass was soon located.

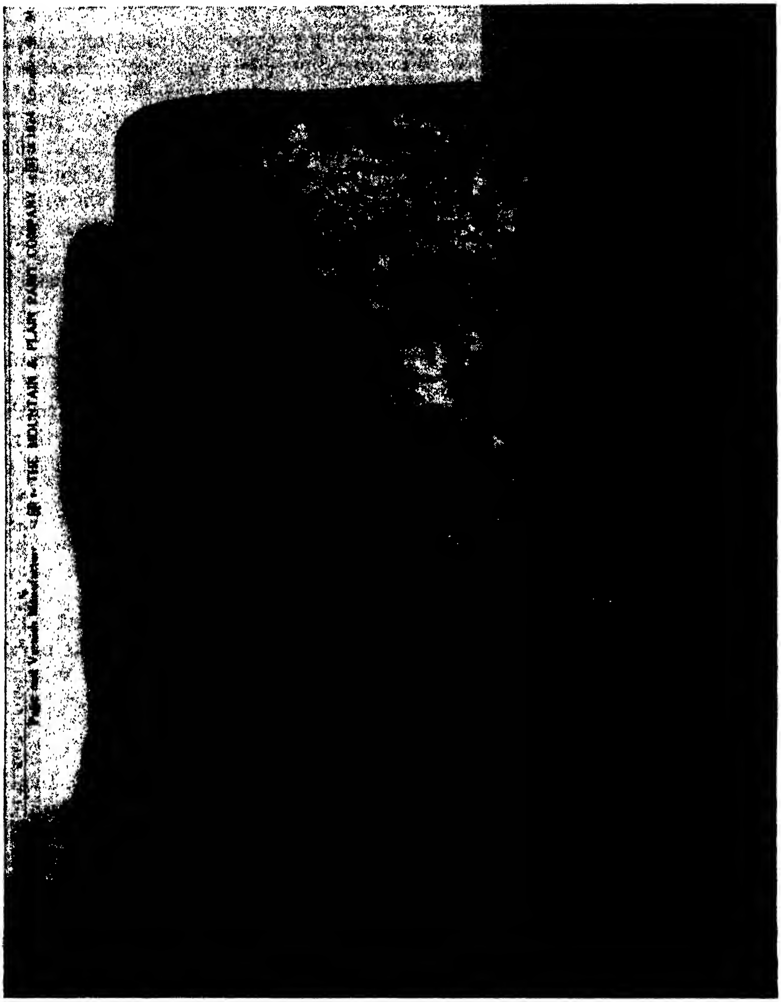

FIG. 4. The Hugoton meteorite as restored and resting on artificial base.

When excavated it was found that the base of the large stone was only 36 inches below the surface of the soil. Its summit probably had reached to within four inches of the surface, but the stone being old and much fractured by weathering, had readily yielded to the plow, so that the uppermost intact portion lay about ten inches under the surface when we discovered it. The

portion actually intact was found to weigh about 715 pounds. Fragments were found sufficient to bring the total weight to 749 pounds; however, the original weight may have been considerably greater than this figure. The original crust was missing from an area about 12 by 18 inches. The large fragment first detached by the plow showed a thickness of six inches. If we allow for a loss of an average thickness of three inches over the broken surface the missing fragments should total about 70 pounds as against the 34 pounds which were recovered. However, this weight is only conjectural, and the weight of the meteorite is recorded as 749 pounds, which is the weight actually recovered. (Subsequently 15 pounds more of fragments have been found. H.H.N.)

While the stone when excavated was found to be very badly fractured, especially in its upper portion, it is believed that this condition was due to weathering and not to impact, for its surface contour was in all respects typical of complete meteoritic stones except for the broken upper extremity above mentioned. All was completely encrusted, save for a few places where chips had been lost, probably from frost action, and much of it was strikingly pitted. (Figure 4.)

Judging from the degree of weathering which the stone had undergone, and considering its behavior in the laboratory and its composition in comparison with other aerolites of known age, it is the writer's opinion that the Hugoton stone had laid in the earth at least a century, and probably twice that long. In view of this great age it will seem strange that anything should be known regarding its fall. Yet it may be stated with a fair degree of certainty that the stone fell from the northwest, for against its southeastern face was found a layer of dark topsoil about three-fourths inch thick. This soil was strongly impacted as would be expected if it had been carried down from the surface with the stone. This face of the stone sloped under at an angle of about 40° with the vertical. It evidently was directed forward at the time of impact.

Geologically the region where the Hugoton stone lay is an aeolian deposit. The topsoil is a dark brownish-gray sandy loam to a depth of about 18 inches. Below this it changes to a yellowish-brown sandy clay with white granules of calcareous material scattered through it. In such a subsoil the intrusion of the dark layer of topsoil above mentioned was very conspicuous.

The field where the stone was found is practically level and shows no evidence of any erosion due to surface water. It is, however, very subject to wind erosion. There was no evidence of any considerable lowering of its general level during the past season. It had grown a crop of corn in 1934 and the bases of the stalks were still standing in March when the find was made. These stalks would have evidenced any considerable lowering of the surface had it occurred.

The stone was uncovered without moving it and photographed as it rested in the excavation. (Figure 5.) Then it was wrapped in burlap and plaster. Two six-foot lengths of one-and-one-half-inch gas pipe were wrapped into the plaster jacket for subsequent use in handling the stone. When the plaster had set, six men lifted the mass into a trailer and it was thus brought to the Colorado Museum of Natural History, where the jacket was removed.

After removing its wrappings the more fractured portion of the stone was taken apart piece by piece, cleaned, and again set together by means of plaster

mixed with gum arabic. Between the various fragments considerable soil had accumulated, together with roots and vegetation. The lower half of the stone as it rested when found was quite well preserved and therefore was not taken apart. The extreme upper portion could not be reassembled because much of it had crumbled and doubtless many pieces were never recovered. A plaster

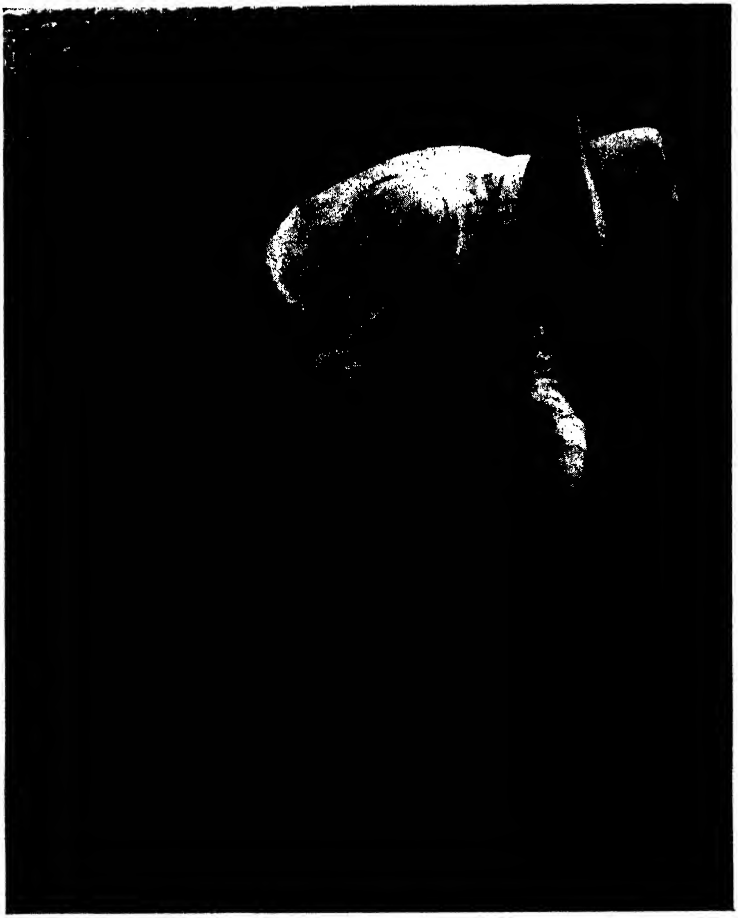

Fig. 5. The Hugoton meteorite as its excavation was being completed. J. D. Lynch, Jr., removing dirt from beneath one end of the stone.

base was built on this unfinished end and the meteorite rests on this base in figure 4.

The stone is cuboidal in form and probably represents only a portion of the original mass which entered the atmosphere; however, no other fragments have been found to date. The original fusion crust has been stained to a dark, rusty-brown color, which is also the color of the interior. A whitish calcareous encrustation covered some of the lower part of the stone.

Polished sections of the fragments show small irregular grains of nickel-iron and numerous grains of troilite. Indications are that much of the original metal content has been completely altered by oxidation. The interior of the stone closely resembles that of the Covert meteorite [4] discovered in 1929 about 200 miles to the northeast. The meteorite is rich in chondrules mostly less than 2 mm. in diameter. These are generally circular in cross-section and they break with the matrix.

The meteorite is permeated by a multitude of minute veins and veinlets of dark brownish black, or in some cases bluish-black color. These appear to be composed of the products of alteration, as do the veins in most meteorites. Metallic grains are notably absent in the vicinity where the veins are most numerous and largest, while in those areas where the veins are small or absent the metallic grains are most abundant. The sulfide has a more nearly equal distribution. Small irregular cavities are quite abundant, especially in those regions where the metallic grains are absent. These probably represent the locations from which metal has been removed by oxidation.

The stone shows evidence of brecciation where a large polished section is examined. It appears to be made up in part of angular or rounded masses. The outlines of these inclusions are not distinct, however, and it may be merely an apparent brecciation due to inequal alteration.

Fissures due to weathering traverse the meteorite in considerable abundance. Some of these are quite large and some merge into the veins described above. In a considerable number of cases, however, they remain unfilled. They appear to be due to differential increase in size in different parts of the mass during the process of alteration and consequent fracturing. After fracturing they have no doubt been enlarged by frost action. If filled by the products of oxidation they appear as "veins," while those which are not so filled continue to remain as open fissures.

A chemical analysis was made by F. G. Hawley and yielded the following results:

CHEMICAL ANALYSIS OF HUGOTON METEORITE

Fragment of 55.896 grams. Metallic constituents found to weigh 0.056 grams; nonmetallic constituents found to weigh 55.84 grams.

ANALYSIS OF ENTIRE SAMPLE

FeO	11.89 percent	MgO	21.50 percent
Fe_2O_3	18.14 percent	K_2O, Na_2O	.45 percent
NiO	1.62 percent	SiO_2	33.21 percent
CoO	.24 percent	SO_3	.36 percent
Cr_2O_3	.48 percent	P_2O_5	.28 percent
Al_2O_3	2.02 percent	FeS	2.86 percent
TiO_2	.11 percent	CO_2+H_2O	4.14 percent
MnO_2	.20 percent		
CaO	2.25 percent		
		Total	99.79 percent

Platinum metals per ton, 0.03 ounces.

THE MORELAND STONE

This stone was first encountered by Mr. Sam Hisey, seven miles north of Morland, Graham county, Kansas, in June, 1935. Mr. Hisey had been farming the field for years and had never before encountered the stone, but while listing the ground for a feed crop in 1935 the share was torn from the lister and the stone was partially upturned. As found, the meteorite was in four

4. Nininger, H. H., and Muillenberg, Garrett A., Jour. of Geol. Vol. 39. 1931.

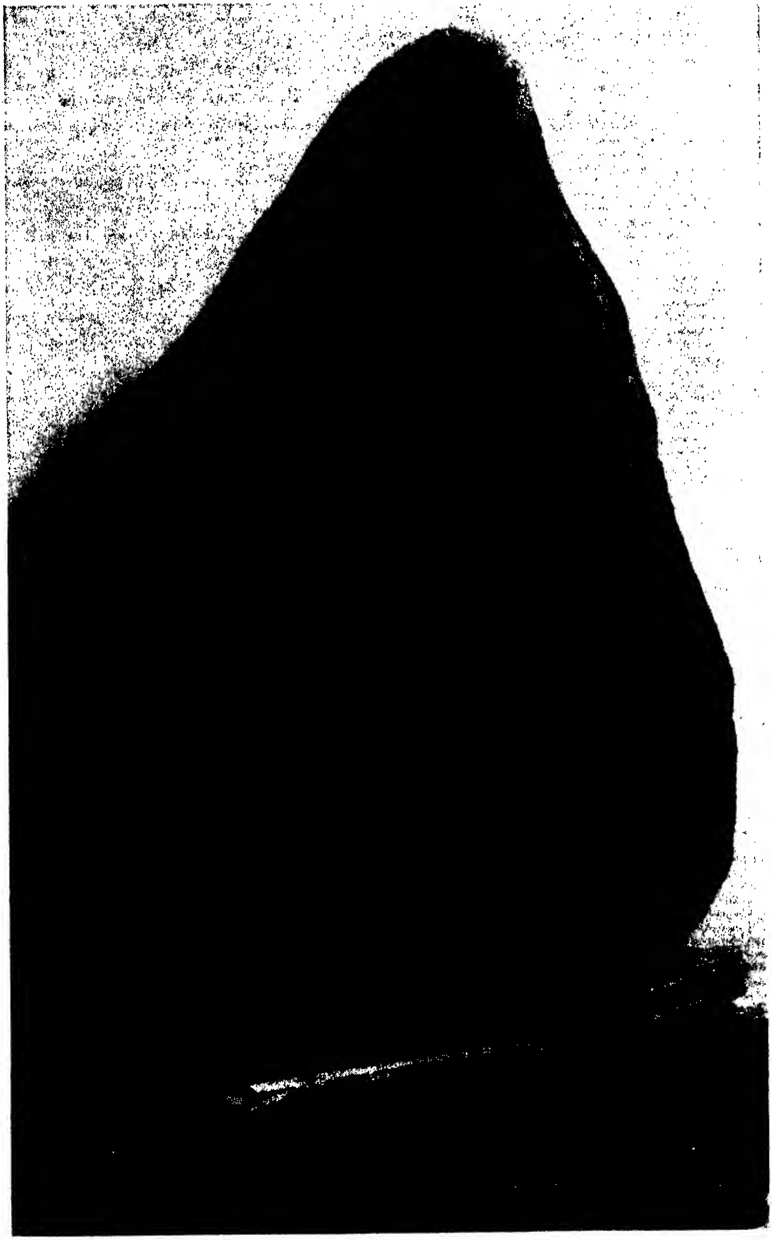

FIG. 6. The Morland meteorite after its restoration; viewed from what is interpreted to have been its rear surface during the oriented flight subsequent to its last disruption.

principal pieces, all of which were in contact and evidently were lying in place before the lister upturned the largest mass. The four fit together to form an almost complete stone.

Finding a stone in a field where he had never before encountered a stone of any kind aroused Mr. Hisey's curiosity and he hauled the second largest fragment (weight 160 pounds) to Morland and sought the advice of Mr. R. R. Dollarhide, who is much interested in various lines of natural history. Mr. Dollarhide forwarded a sample to the Nininger Laboratory, where its meteoritic character was at once recognized. A visit was made to the spot where the stone had been found and the entire find was purchased jointly by the Nininger Laboratory and Mr. Dean Gillespie of Denver, Colo.

The Morland meteorite, while not abundantly fractured like the Hugoton stone, yet shows evidence of considerable age. Its color is dark reddish brown on the surface, which is entirely enveloped by the original fusion crust. The interior of the stone appears on fresh fracture as a dark greenish brown, almost black, and by grinding an abundance of metallic grains become evident, as do also numerous chondrules. Neither of these constituents is positively revealed by fracture.

The specific gravity was determined on a mass of 1,082.7 grs. from the interior of the meteorite and found to be 3.57.

The form of the Morland stone indicates that a parent mass was fractured during flight. (Figure 6.) It is in the form of a thin angular block which had undergone but little ablation subsequent to the last fracturing. It is bounded by eight very unequal facets, each of which is almost a plane. Six of these are relatively much smaller than the other two. The smaller facets show little or no pitting, but appear wind-swept, bearing striations which run almost at right angles to the two broad faces of the stone. The two large planes lie nearly parallel, about 10 to 13 inches apart. One is irregularly pitted and more or less undulating. The flatter of the two is rather uniformly marked with broad shallow pits which are from 3 to 6 cm. in diameter and for the most part only 2 to 3 mm. deep. In a proper light this presents a dappled appearance. (Figure 6.) Apparently there was a brief period during which the mass traveled broadside with this flat side toward the rear. The striations above mentioned seem to plainly indicate this course for the stone.

Altogether, however, the stone shows much less pitting and other frictional sculpturing than does the Hugoton stone. It also shows not sufficient frictional shaping for a stone of unbroken atmospheric flight. The writer believes that its general form was attained rather late in flight and that this accounts for the small amount of shaping which characterizes the meteorite. Further evidence of aerial disruption is found in the fact that another stone was picked up more than fifty years ago on a farm two miles to the west. This stone was used in a foundation for a corncrib. Its size is estimated at 75 to 150 pounds by the man who now owns the farm. He reports that the stone crumbled and went to pieces. He later poured a concrete foundation under the building. My search was rewarded by the finding of six fragments of the stone, weighing together three pounds. An examination of the material in a polished section indicates that a greater proportion of the metallic constituents had been altered by its greater exposure due to crushing. It is probable that other fragments of the Morland meteorite are buried in the vicinity.

The finding of the Hugoton and Morland stones so near the surface, both of them in the Great Plains region, where fluviatile erosion goes on at a minimum rate, suggests an interesting problem regarding the effectiveness of wind as an agent of gradation in this region. There are recorded but five individual aerolites whose weights exceed 600 pounds each. Four of these have been found in the Great Plains area. A fifth was that which fell near Paragould, Ark., in 1930. This stone buried itself more than eight feet in the soil. It was only found because the fall was known to have occurred in the region. The small crater which it produced betrayed its location to an observant farmer after the writer had made a survey of its fall and had then instructed the local residents where to search for the mass. It was found on the line which was designated. This, no doubt, had much to do with the finder recognizing it.

The mere fact that four falls, each represented by such large stones, should have occurred on the Great Plains is not in itself so important. Probably any other area of equal size has received a comparable increment of large stones; but this happens to be the only area where the fact has been proven. Years of effort by way of a search preceded the finding of two of these stones.

CHEMICAL ANALYSIS OF MORLAND METEORITE by F. G. HAWLY

Fragment of 24.122 grams. Metallic constituents, 0.202 grams; nonmetallic constituents, 23.920 grams.

ANALYSIS OF ENTIRE SAMPLE

FeO	14.58 percent	MgO	22.05 percent
Fe_2O_3	13.85 percent	K_2O / Na_2O	.40 percent
NiO	1.54 percent	SiO_2	35.40 percent
CoO	.24 percent	SO_3	.54 percent
Cr_2O_3	.57 percent	P_2O_5	.31 percent
Al_2O_3	2.15 percent	FeS	3.79 percent
TiO_2	.11 percent	CO_2+H_2O	2.24 percent
MnO	.13 percent		
CaO	2.35 percent	Total	100.26 percent

Platinum metals per ton, 0.28 ounces.

THE HAVILAND CRATER

The most important meteorite discovery within the state during this period, or, for that matter, during the state's entire history, was the recognition and excavation of a small crater near Haviland, in Kiowa county. Known meteorite craters are rare on the earth, and up until 1933 all efforts to find meteorites in the depths of craters had failed. Meteorites had been found in abundance in the vicinity of the well-known meteorite crater of Arizona; but none had ever been recovered from within the pit. The same may be said of the Henbury craters in Australia and of the Wabar craters in Arabia, as well as the Odessa, Texas., crater.

The Haviland crater, however, proved the exception in this respect. Subsequent to its excavation an iron nearly 500 pounds in weight has been recovered from one of the small Henbury craters; but our excavation in June, 1933, was the first case on record where meteorites were recovered from a crater. In it not only were meteorites found but thousands of them were studied in situ. This furnished tangible evidence of a kind never before obtained regarding the behavior of large meteorites upon their impact with the soil. (Fig. 7.)

It is unfortunate that this crater had escaped recognition during those earlier years when this field was being searched for meteorites during the '80's and '90's of the last century. The majority of the specimens found during those years were found distributed on all sides of the little crater, which was regarded as an ordinary buffalo wallow. At that time the field was still in

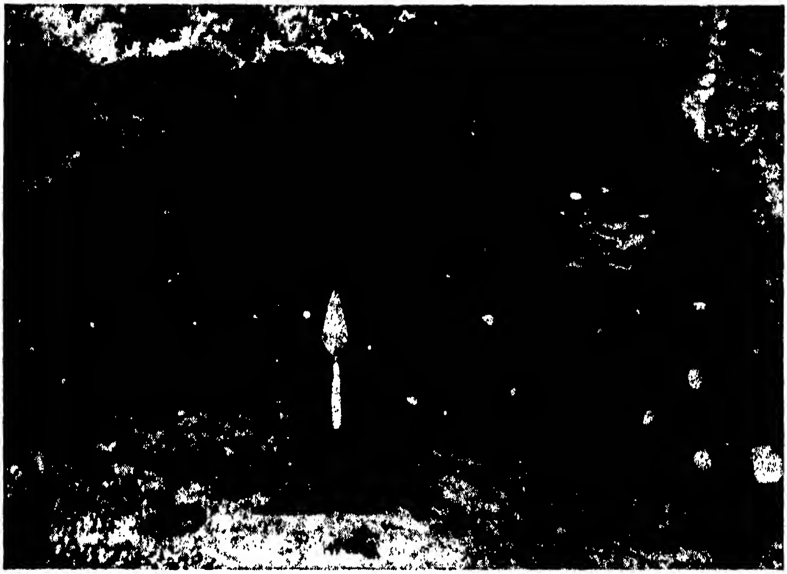

FIG. 7. A part of a longitudinal section through the Haviland meteorite crater, showing meteorite fragments (painted white) in situ. The trowel rests on the floor of the excavation about five feet below the general surface level and about midway between the deepest point and the perifery of the meteorite-bearing horizon. The center of the crater is to the right of this section.

native grass sod and doubtless exhibited graphically the original form of its rim and the pit. In contrast, when the writer first saw it in 1925, the field had been farmed for nearly thirty years. Even the depression itself was cultivated each year and naturally all of its more delicate features were seriously marred or erased. Indeed some effort had been made to fill up the hole so as to render it less troublesome as a mudhole. The size of this crater, together with its contents as revealed by our excavation, have been described in the Proceedings of the Colorado Museum of Natural History, vol. 12, No. 3.

The Study of Geology—Its Values

LYMAN C. WOOSTER, Emporia, Kan.

Below the college the elements of geology serve as an excellent substratum to a knowledge of geography. No teacher of physical geography, especially, can do his best work without having had a course in college geology. By college geology I do not mean a study of mining, rock quarrying, and oil prospecting, but a course that gives a valuable knowledge of the environments of plants, flowers, animals, and of people in general. Such a course could be named the ecology of geology.

A course in geological ecology should give the student a knowledge of the earth's surface, of its hills, plains, and valleys; of its atmosphere, with its storms of wind, rain, and snowfall; of the crust of the earth, of its quakes, volcanoes, mountains, and minerals, and more especially of its soils, ponds, lakes, rivers, and oceans; indeed, of all the environments which favor or give hardships to every form of life that must survive or perish on this planet in longer or shorter periods of time.

The early students of physiographic ecology believed that the earth forces worked spasmodically like the eruptions of volcanoes, the appearance of tornadoes, and the coming of floods; but Lyell proved in his "Principles of Geology" that geologic causes are so long in operation that they may be successfully studied, and that the effects follow so regularly that they may be predicted with the certainty of the coming of summer and winter, and usually with as great certainty as the expectation that day will follow night.

The student in geology will early learn that after the Ozark uplift, Kansas for hundreds of millions of years sloped from the east to the west, but that this slope was broken to give room for a range of Kansas mountains, the Nemaha mountains, which extended from what is now Butler county to Nemaha county. With the exception of this interruption, the slope continued to salt water towards the western end of the state. As a result of this slope the rock formations are oldest at the east, and youngest at the west, the strata following one another like the leaves of a book. But some millions of years ago the Rocky mountains pushed up in the midst of the salt waters and tilted Kansas to the eastward so much that the western end of the state is now more than 3,000 feet higher than the eastern end, thus reversing all her river systems and seriously modifying her climate and changing her environments.

But the plants and animals living then were not seriously inconvenienced by the change in slope, for their homes were mostly in the water or on the prairies or in the swamps. They had little trouble in finding new homes.

By the time man reached what is now Kansas, the Nemaha mountains had been buried from view by the late rock formations; her surface was much as we find it today; and the winds, rainfall, droughts and dust storms had been well established for many thousands of years.

But the plant and animal ecology, involving the reactions of life to the many environments, gives the student unending enjoyment in solving the myr-

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iad problems of adjustment needed to bring each form of life abundant success in its struggle for existence. The river bottoms and the upland plains were ideal homes for herbivores and carnivores. For millions of years they witnessed the most intense struggles for food and comfort, struggles that have resulted in the evolution of the highest types of plants and animals.

THE PLANT AND ANIMAL INHABITANTS

For many years the plant biologists have been intensely interested in the work of locating each kind of plant in its appropriate species, genus, family, order, and phylum, and in the work of arranging these groups in a linear series, beginning with the lowest and ending with the highest.

The animal biologists have also classified the animals and arranged the groups in a linear series from the lowest to the highest. They have found many uncertainties and a few gaps in each series.

The embryologists have studied the developments of the individual plants and animals and have found a wonderful recapitulation by each higher form of the antecedent lower forms.

The geologists have studied the fossilized remains of the plants and animals in all the rock strata, from the oldest to the most recent, and have been surprised to learn that their series of plants and animals possessed a remarkable similarity to the series arranged by the biologists and embryologists.

Each series helps in explaining the other two and fills many of the gaps. Then too, many plants and animals have found environments that have changed very little in many millions of years, so the old forms have persisted and consequently may be called stay-behinds or left-behinds. These serve in many ways to explain the geological record and to fill the gaps found by the biologists.

The geologists, with these perfected records before them, can use them in identifying and in fixing the age of all the strata on the face of the earth. Without this record they would be completely lost in their attempt to make a geological survey of the rocks of Kansas and to compare their work with similar surveys in other states and countries.

I have time to speak of but a few of the many consequences that have resulted from the geologic structure of Kansas.

When the slope of what is now Kansas was changed from a slope to the west to a slope to the east, great lakes occupied the western part of the state for thousands of years. The fine silt of these lake bottoms produced most excellent buffalo grass, but since it has been cultivated for wheat it has become a prolific source of dust storms.

The flinty chert of the Wreford limestone has resisted erosion so well that we have the Flint hills, or Permian mountains, the home of most excellent Kansas beef.

The iron oxide has made certain layers of the Dakota sandstone so hard and so resistant to erosion that it has saved Pawnee Rock for Coronado and many battles with the Indians. These layers have also preserved the cliffs of the natural corals of McPherson county for herds of cattle and Sunday-school picnics.

The sand of this Dakota sandstone blew in from an old lake bed. Some of it lodged in great clumps of Chara and made the great cannonball "concretions" that now stand in rows near Minneapolis, Kan.

The soft chalk-limestone that borders the Smoky Hill river in Gove county has been cut into castles and pinnacles by the infrequent rains of that part of Kansas.

Some great volcanoes of the Rocky mountains, possibly near Trinidad, shot out great quantities of volcanic ash, which was carried by westerly winds into Kansas. As a result, there is in this state millions of tons of Old Dutch Cleaner abrasive material, enough to last thousands of years.

Before the Rocky mountains came up in the western ocean during the Eocene-Miocene epochs of the Tertiary period, some twenty million years ago, according to the new chronology, what is now Kansas was undoubtedly well covered with vegetation; the Dakota sandstone of Kansas contains the leaves of 450 species of forest trees, according to Leo Lesquereau (Lā-kĕ-rò), an eminent paleobotanist. Among these are the leaves of willow, fig, eucalyptus, sassafras, walnut, sequoia, sweet gum and many more. (Vol. 17, p. 130, Acad. Transactions.)

But with the great change of slope, drainage, climate and rainfall that followed the rise of the Rocky mountains, the forests became restricted to the creek and river valleys, as we know them today. Here they find the water which they must have to survive.

"The Handbook of Kansas Trees," by Dr. F. C. Gates, gives the surviving power of the different kinds of trees in fractions indicating their ability to survive with a more and more scanty rainfall from the east line to the west line of Kansas. The fractions given below indicate the part of the distance from the eastern border that they are able to survive without help by man:

American elm, ¾; soft maple, ¼; bur oak, ½; black walnut, ¾; sycamore, ½; linden, ¼; papaw, ¼; red mulberry, ½; persimmon, ¼; crab apple, ¼; red bud, ½; the locusts, ½; buckeye, ½; boxelder, ½; coffee tree, ½; red, pin and black oak, about ⅓; shagbark hickory, ¼; black cherry, ¼; hawthorne, ¼; white ash, ¼, and Chickasaw plum, as far west as south central Kansas.

The willow, green ash, cottonwood and red cedar go beyond the Colorado line and grow up in that western land of sunshine and dry weather. The grasses and sunflowers know no limits by state lines.

Those who are wise in reading the signs of the times will see at once that this distribution of the different species of plants, the result of millions of years of experience with the climate of our state and its soils, is an almost infallible guide to those who would find homes in the different parts of Kansas. It shows them what to plant and what not to trust to the great out-of-doors.

With this testimony of the vegetation and of the animals before him, man in his wisdom can modify to some extent the deficiencies of rainfall and the barrenness of soils.

The rainfall of Kansas averages about 30 inches each year. One inch of rain gives more than 100 tons of water to the acre. Thirty inches, therefore, would leave on each acre of land more than 3,000 tons of water each year. Of this amount, part runs off in our creeks and rivers. The runoff may be lessened by terracing the surface and by plowing at right angles to the slope. More of the water will then soak into the ground for the use of plants.

The run off may be lessened by retaining it in reservoirs, lakes, and ponds. By the construction of dams across river and creek valleys the danger from floods would be lessened.

The water of the runoff takes with it the richest part of the soil and frequently deposits it where it cannot be used for crops till many years have elapsed and the basins are silted full. But the landowners have the satisfaction of knowing that the made lands are near their homes.

When the lakes are stocked with fish and the fish are supplied with their natural foods (this is too often neglected), the lakes may be made to yield valuable food for the tables. The chief fish foods are water plants, tiny crustaceans, fish eggs, fish, and small animals other than the crustaceans.

Unless the atmosphere is kept moist by the evaporization of water from reservoirs, lakes, ponds, moist earth, and the transpiration from herbaceous plants and forests, the rains will be infrequent and small in amount. It is well known that the rains are heavier near the earth than on the tops of tall buildings.

Gulley-washing must be stopped at their beginnings by brush and blocks of limestone or other rock, or many valuable acres of land will be ruined for cultivation. Even the general surface of a farm may be lowered by improper cultivation. At the United States Experiment Station at Bethel, Mo., where the slope averages less than 8 percent, it was found that bare ground lost 22 tons of soil per acre from April 1 to December 1. The annual loss from corn land was 17 tons per acre, and from wheat land, 7 tons—all this with less than the average rainfall.

The soils of the Kansas uplands are mostly derived from the subjacent limestones, shales and sandstones, the decay of plants and animals, and their natural refuse. The glacial drift soils of northeastern Kansas constitute the chief exception. These are composed of what the Kansas and possibly the Iowa glaciers carried and shoved into the state from the similar rocks of Iowa, Missouri, and Kansas. The reddish quartzite boulders from South Dakota and Minnesota do not yield soil material, and they resist decay in the atmosphere. The river and creek bottom lands are made up of wash from the uplands and from the decay of organic matter.

The records obtained by Miss Laura M. French for her "History of Emporia and Lyon County" show that in that part of eastern Kansas the rivers have been at flood stage, on the average, once every three years for more than seventy years. The other parts of eastern Kansas show similar records. In consequence of these floods the wise ones build on land higher than the flood levels.

The soils of eastern Kansas, at least those about Emporia, are abundantly supplied with potassium carbonate. This when attacked by the nitric acid of rainwater becomes potassium nitrate, a valuable fertilizer. The practice of burning wheat straw and cornstalks on the land is not helpful to the soil—not so helpful as rolling this material into the surface with a corrugated roller to prevent dust blowing and making an addition to the humus, which is being badly depleted in Kansas.

The important minerals derived from the rock strata of our state are coal, lead, zinc, oil and natural gas. All these are studied by specialists under the direction of the owners of the mines and wells. The oil and natural gas industry is largely tributary to that of Oklahoma, except that in western and northwestern Kansas.

When the Nemaha mountains sank some time in the Mississippian or early Pennsylvanian periods, its drainage system of rivers became more and more

sluggish and their valleys, consequently, filled with sand. The sand gave easy passageway to oil and gas from the Oklahoma field into Kansas territory where it has been reached by Kansas wells.

The accumulations of oil and gas in western Kansas seem to have been made under the action of a different set of forces. These hydrocarbons are found largely in a limestone. It is possible that when western Kansas was flexed by the rise of the Rocky mountains, the gas and oil collected in a fissured limestone under the domelike structures found in that part of the state.

Where and how these hydrocarbons originated under Oklahoma and western Kansas, no one knows. We do know that plants are killed by hydrocarbons; but they use immense quantities of carbon dioxide to get the carbon in food-making. Possibly the fissures in Oklahoma and the fissures opening downward in flexed western Kansas permitted them to come up from the hot regions below.

Vitamin A and Carotene Determinations on a Sample of Commercial Butter[1]

Bernice L. Kunerth and Sister Ethelburg Leuschen, Kansas State College, Manhattan, Kan.

There is now much interest in the various methods of determining vitamin-A value of food products. Originally, biological assays were used in which rats, produced under standard conditions and depleted of their reserves of vitamin A, were given portions of the test food so their growth response could be measured. This method, although still considered the fundamental one, is expensive as well as time and labor consuming, and, in addition, involves a possible error of as much as 25 percent, because the growth response of animals is seldom uniform.

In the interests of greater speed and accuracy, chemical and physical methods have been developed for determining vitamin A and carotene. A sample of commercial butter purchased in February was tested for total vitamin-A activity by such methods.

Carr and Price (*1*), and more recently Coward (*2*) and others have developed a method for the quantitative estimation of vitamin A, which depends on intensity of the blue color developed in the vitamin concentrate when treated with $SbCl_3$ in $CHCl_3$. A potent source of vitamin A, such as haliver oil, shows the blue color directly, but the vitamin-A content of less potent sources is more satisfactorily measured if the vitamin is first concentrated.

According to the methods of the Society of Public Analysts (*3*) and of Gillam (*4*) duplicate samples of butter of 15 gm. each were saponified 10 minutes with 100 ml. of freshly prepared alcoholic potash (5 grams KOH in 100 ml. alcohol). Three volumes of cold water were added to the solutions, which were chilled to 0° C. and extracted with 200 ml. peroxide-free ether, used in 4 to 6 different washings. The combined ether solutions which contained the vitamin A were washed once with water, once with dilute alkali and twice with water, approximately 200 ml. being used in each washing. The sample was then freed from ether with reduced pressure under an atmosphere of nitrogen, taken up twice with a few drops of absolute ethyl alcohol and again blown dry. The residue resulting was dissolved in a few drops of anhydrous $CHCl_3$ and made up to 3 ml. One half ml. of this solution was added to 4.5 ml. of a saturated salution of $SbCl_3$ in $CHCl_3$ and its intensity measured visually in a Bausch and Lomb spectrophotometer. This instrument was used to measure the density of the blue solution at the two wave lengths of light 620 mμ and 583 mμ where vitamin A exhibits maximum absorption in the solvent used. Frequently a tintometer, equipped with standard colored glasses, is employed and the vitamin A is expressed in blue units. As no tintometer was available and also as there is some question concerning the reliability of the standard glasses over a period of time the spectrophotometer was used.

The results secured by the $SbCl_3$ method are presented in table 1. By use of the formula $D = E\,C\,L$, where D is the density read directly from the

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1. Contribution No. 48, Department of Home Economics.

spectrophotometer, L is the length of the cell through which the absorption is measured, and C is the percent concentration of the sample in the solution tested, the value of the extinction coefficient for the particular sample is calculated. For a 1-percent solution of a sample containing almost pure vitamin A, the value of the extinction coefficients measured in a 10 mm. cell at 620 mμ and 583 mμ have been determined to be 5,000 and 2,600 respectively, and in this paper these constants are represented by K (*7*).

From the ratio of the extinction coefficient, obtained experimentally, to the constant, the percent of vitamin is calculated. This may be expressed in gammas (γ) of vitamin A by moving the decimal point, as 1 gamma is one millionth of a gram. Another term has been introduced in vitamin work, the international unit, and amount of vitamin A may be expressed as international units, by multiplying the results in gamma by the factor 1.56. The results in the eighth column are expressed with regard to butter and those in the last column are on the basis of butterfat. This facilitated comparing our results with those of Baumann and Steenbock (*5*), who found similar results for February butter.

Another method of making a quantitative determination of vitamin A is that of measuring the absorption in the ultra-violet region at a wave length of 328 mμ where the extinction coefficient of a 1-percent solution of the pure vitamin A is 1,600. The preparation of the sample is similar to that already described, except that the washed ether solutions after drying over anhydrous Na_2SO_4 were freed from ether and dissolved in hot methyl alcohol and chilled below -20° C, for several hours, filtered, made up to a volume of 25 ml., and sealed off in ampules in an atmosphere of nitrogen. Because the absorption maximum is in a region in which the eye is not sensitive, spectrograms on photographic plates were made. The instrument used for this experiment was a Bausch and Lomb quartz spectrograph equipped with a Hilger rotating sector disc, and a quartz biprism. Calculations are similar to those mentioned above. The results based on the intensity of the absorption at 328 mμ are considered by De (*6*) and others to be high, indicative of absorption due to some source not affected by ultra-violet and to vitamin A which upon long exposure is destroyed. However, the results presented in table 1 are used without correction, which is in accordance with other work.

β-carotene, a precursor of vitamin A, is converted into the vitamin in the animal body by splitting the molecule with water. According to Morton (*7*) carotene is frequently found in vegetable products but vitamin A is absent. In butter and milk, however, he reports both carotene and vitamin A to be present in small amounts. Therefore, to get the total vitamin A value of a food, the fraction due to carotene must also be determined.

The carotene from duplicate samples prepared for the spectrograph readings at 328 mμ was extracted by diluting the absolute methyl alcohol solutions with water to approximately 90 percent and separating the carotene from all the xanthophyl and the major portion of vitamin A by adding skellysolve, a light petroleum ether. This procedure is similar to that of Gillam and Heilbron (*8*).

The solutions of carotene were read in the spectrophotometer at the three different wave lengths (table 2) where Peterson (*9*) has observed maxima for

skellysolve solutions of β-carotene and the constants determined by him were used in making the calculations for the extinction coefficients and percentages of carotene. The factor 1.66 was used in converting γ of carotene to international units because 1 gram of β-carotene is capable of being transformed into 1.067 grams of vitamin A which equals 1.66×10^6 I. U.

The total vitamin A value is the sum of the international units determined for vitamin A and carotene. For the butter tested this value is estimated as about 18 international units per gram of butterfat. This result is of the same order as that of Baumann and Steenbock (*5*) who report 2.2 γ carotene determined in the spectrophotometer and 11 γ of vitamin A determined in the quartz spectrograph for a sample of February butter per gram of butterfat. The findings here presented are consistent with results of others in that the greater portion of the vitamin A value is due to vitamin A itself. In this sample of commercial butter about one fifth of the vitamin A value is due to carotene and four fifths to vitamin A.

The authors are indebted to Dr. J. W. Woodrow, head of the department of Physics, Iowa State College, for use of equipment necessary for spectrograph determinations, and to Dr. William Kunerth for kind assistance in operating the quartz spectrograph.

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TABLE 1.—Vitamin A determinations on unsaponifiable fractions of a commercial butter

	Preparation.	Equipment used.	#	$E^{1\%}_{1cm}$ $\text{Log} \frac{I_0}{I} \div Cl$	Vitamin A. $\frac{E^{1\%}_{1cm}}{k} \times 100 =$ % vit. A	Per gm. butter. $1\gamma = 10^{-6}$ g	Per gm. butter. $1\gamma = 1.56$ I. U.	Per gm. butterfat.
Blue color 620 mμ (K = 5000)	$CHCl_3$ $SbCl_3$	Spectro-photometer.	A B	.028 .010	% .00056 .00020	γ 5.6 2.0	I. U. 8.7 3.1	I. U. 10.9 4.0
583 mμ (K = 2600)			A B	.018 .009	.00069 .00035	6.9 3.5	10.8 5.4	13.5 6.8
U. V. ab. 328 mμ (K = 1600)	CH_3OH	Quartz spectrograph.	A B	.013 .012	.00081 .00075	8.1 7.5	12.6 11.7	15.8 14.6

455 mμ (K2380)
470 mμ (K 2000)
480 mμ (K = 2120)

TABLE 2.—Carotene determinations of unsaponifiable fractions of a commercial butter

Preparation.	Equipment used.	#	$E^{1\%}_{1cm}$ $\text{Log}\frac{I_0}{I} \div Cl$	Carotene.			
				$\frac{E^{1\%}_{1cm} \times 100}{k} =$ % carotene	Per gm. butter. $1\gamma = 10^{-6}$ g	Per gm. butter. 1γ β carotene = 1.66 I. U.	Per gm. butterfat.
				%	γ	I. U.	I. U.
Skellysolve (light petroleum ether).	Spectro-photometer.	A	.0042	.000176	1.8	3.0	3.8
		B	.0035	.000147	1.5	2.5	3.1
		A	.0036	.000180	1.8	3.0	3.8
		B	.0031	.000155	1.6	2.7	3.4
		A	.0038	.000179	1.8	3.0	3.8
		B	.0030	.000142	1.4	2.3	2.9

Electrons Moved by Interference Between Their Waves

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Electrons, positrons and protons are composed of fields of waves of assumed fundamental wave-length, $\Lambda = 2\,e^2/3\,m_o c^2 = 1.87 \times 10^{-13}\,cm$. Overtones of the fundamental occur in neutrons and in protons, and are responsible for most of the mass of the latter.

In the case of interference between the waves of two elementary charges, the system becomes doubly periodic with periods, Λ/c and r/c. r is the distance between the most probable (as determined by the intensity, Schrödinger's maximum $\Psi\bar{\Psi}$) points of location of the elementary charges, and is the wave-length of a plane waves component of the system.

Λ is the wave-length of a number of spherical components of the system, which have their ray-centers at $O, r, 2r, 3r, \ldots. nr$, in the line of r extended. All of the ray-centers have the same phase at any given instant of time.

The interference between the several trains of (similar to Huygens') spherical wavelets is like that of a diffraction grating, but with pattern rotated around the line of r as an axis of symmetry. The wave fronts, resulting from the interference, are envelopes of groups of spherical wavelets that have the same phase; and they are right circular cones which have the line of r as their axis.

The angle Θ_n between the axis and an element of an n-th order cone is determined by $n\Lambda = r \sin \Theta_n = r \cos \alpha_n$. To simplify this brief discussion, we shall consider only the first order cones. Therefore, $\Lambda = r \sin \Theta = r \cos \alpha$.

The wave normals of the conical wave fronts form a right circular cone. Its angle between the axis and an element is α. Assume that the velocity of radiation of energy in an element of this cone is c, directed away from the vertex in the case of like charges, and directed ($-c$) toward the vertex in the case of unlike charges. The axial component of this velocity is $v = \pm c \cos \alpha = \pm c\Lambda/r$, where positive sign is for repulsion, and negative sign is for attraction.

Assume that v tends to impart the velocity, $v' = 3v/2$, to a positron or electron, and that the acceleration is defined by $dv'/dt = -c\, dv'/dr = \pm 3c^2\Lambda/2 r^2 = F/m_o = \pm e^2/m_o r^2$. Therefore, $m_o = 2\,e^2/3\Lambda c^2$.

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Simple Wave Equation Showing Barrier

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Starting with the wave equation of optics, after the time is eliminated, $\Lambda^2 u + (4\pi^2/\lambda^2)u = 0$, Schrödinger obtains $d^2u/dx^2 + (8\pi^2 m/h^2)\ (E\text{-}V)u = 0$ for one-dimensional motion in wave mechanics. The approximate solutions by the Wentzel-Kramers-Brillouin method are

$$u' = A\ (V\text{-}E)^{-1/4}\ exp \left\{ (2\pi/h) \int^{x} [2m\ (V\text{-}E)]^{1/2} dx \right\}, \ldots x < x_1,$$

$$u = B\ (E\text{-}V)^{-1/4}\ sin \left\{ (2\pi/h) \int_{x_1}^{x} p\, dx + k \right\}, \ldots x > x_1 .$$

It can be shown that, for continuity of u and u' at x_1, $k = 2\pi/8 = 45\ deg.$ The surface through x_1, serving as a boundary between the regions occupied by the exponential and oscillatory solutions, is the well-known potential barrier.

There is an equivalence between much of the W-K-B method and the following simpler set of equations. In place of the time-eliminated wave equation of optics, write $(d^2u/dx^2)\ sin^2{}_a + (1/x)\ (du/dx)\ cos^2{}_a + (4\pi^2/\lambda^2)u = 0$, which becomes the time-eliminated wave equation of optics in one dimension when $a = 90\ deg.$ Solutions:

$u' = A\ exp\ (\text{-}2\pi\, i\ tan\pi - 0.34657), \ldots x < \lambda,$

$u = A\ sin\, 2\pi\ (tan_a + 1/8), \ldots\ldots\ldots\ldots x > \lambda, \ldots$ *where*

$cos_a = \lambda/x, sin_a = (x^2\text{-}\lambda^2)^{1/2}/x, tan_a = (x^2\text{-}\lambda^2)^{1/2}/\lambda .$

When $x = \pm\lambda$, $u' = 0.7071\, A = A\ sin\, 2\pi/8 = u$. It may be shown that $d^n u'/dx^n = d^n u/dx^n$ when $x = \pm\lambda$. The surface through $x = \pm\lambda$, serving as a boundary between the regions occupied by the exponential and oscillatory solutions, is, therefore, equivalent to the W-K-B potential barrier. In fact, the above simple equations may be given the form of the W-K-B equations by the same substitutions which transform the wave equation of optics into the Schrödinger equation.

When a consistent vector system of directions is assigned to u, x and λ, the wave motion, described by the above simple equations, has conical wave fronts.

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A Vacuum Tube Amplifier Model

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Models have been used extensively in the field of physics. Atomic theories and simpler situations have all profited to a large extent provided one does not ignore the limitations of the model. The value of a model lies in its ability to coördinate a number of ideas about any particular subject or theory. The model is also a point of departure in evolving new correlated facts.

The model of a vacuum tube power amplifier described here is very simple and, seemingly, very obvious. Yet the author has found it to be very effective in making clear some of the funadamental characteristics of the amplifier.

A small rodent trap A is mounted on a stout board above a larger trap. A string passing through eyelets is fastened between the spring of the small trap to the trigger of the larger trap B. The spring of the latter trap is connected by a stout cord to a five-kilogram weight W resting on the edge of some near-by chair.

The operation consists in setting both traps. A small weight w attached to a string is allowed to rest on the trigger of trap A, thus releasing the spring. The movement of this spring is transferred by means of the string to the trigger of the larger trap B. The heavy spring, upon being released, drags the five- kilogram weight from the chair. It falls to the floor.

Basically, the model shows how a small impulse or signal voltage w, applied to the grid of the input tube, may release or control a large amount of energy in the output of a power tube W. The trigger of each trap is the grid of the tube, while the energy in the plate circuit is represented by the energy in the spring. The output of the first trap must excite the input or trigger of the second stage or larger trap.

To do this the following points are in evidence:

(1) There is a minimum grid voltage input to an amplifier that will cause it to function as such. Thus, w can be made so small that trap A is not sprung. The first trigger, if too sensitive, would be released by the vibrations of footsteps approaching it. In an amplifier, the sensitivity must be no less than several microvolts. Otherwise, the "shot" effect and thermal effects would produce a background of noise.

(2) The coupling between the stages is represented by the string S. Thus, the slack in S can be so great that trap B is unaffected or only partially affected so that the spring of the second trap is not released.

(3) In a power amplifier, the first tubes need only be, essentially, voltage amplifying tubes which are to provide the large grid swing in the power tube. This large grid swing causes energy to be dissipated in the load. Here, the first trap is a light trap to provide a large swing to the second larger trap. Since the large trap is really quite sensitive, requiring a very small displacement of the trigger to release the spring, the trigger here has been loaded to make it more analagous to the amplifier.

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(4) There is an optimum load W for the amplifier. If W is too small, the trap B will spring over very rapidly, and the energy is spent in the trap rather than in the load. Too large a load, on the other hand, prevents the operation of the trap. Thus, if too large a load or resistance is used in the plate circuit of a vacuum tube, the plate voltage will become practically zero and the tube cannot operate. This is due to large potential drop over the load which will almost equal the supply voltage. If the load on the large trap is too large, the total force of the spring will be on the cord to the load but the energy will not be released.

(5) The larger movement of the spring on trap A causes the trigger of trap B to move farther than the trigger of trap A. Therefore, the bias of each succeeding tube in an amplifier must be generally higher, as well as its plate voltage, so that the grid swing will vary the plate current over the straight part of its grid voltage-plate current characteristic.

The Course Offerings and Curricular Requirements of Psychology in Schools of Diversified Technology

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The optimum ratio of course utilization to course offerings for high efficiency in any subject such as psychology would be difficult to determine and more difficult to attain. An accurate determination of the existing ratio of utilization to offerings for psychology in many different schools would likewise require intensive and careful investigation. But it is possible, through the study of catalogue announcements for different colleges, to determine roughly what offerings are being made in a particular subject and what use may be made of those offerings for training in different lines of work.

PROCEDURE

The data for this study were obtained from the catalogues of 25 schools of diversified technology. The names of these institutions and the year of the catalogues studied appear below.*

- Alabama Polytechnic Institute, Auburn, 1931-1932.
- Agricultural and Mechanical College of Texas, College Station, 1932-1933.
- Carnegie Institute of Technology, Pittsburgh, 1932-1933.
- Colorado Agricultural College, Fort Collins, 1932-1933.
- Georgia School of Technology, Atlanta, 1931-1932.
- Iowa State College, Ames, 1932-1933.
- Kansas State College of Agriculture and Applied Science, Manhattan, 1932-1933.
- Louisiana Polytechnic Institute, Ruston, 1932-1933.
- Massachusetts Institute of Technology, Cambridge, 1932-1933.
- Massachusetts State College, Amherst, 1932-1933.
- Michigan State College, East Lansing, 1932-1933.
- Montana State College, Bozeman, 1931-1932.
- North Carolina State College of Agriculture and Engineering, Raleigh, 1932-1933.
- North Dakota Agricultural College, Fargo, 1931-1932.
- Oklahoma Agricultural and Mechanical College, Stillwater, 1932-1933.
- Oregon State Agricultural College, Corvallis, 1931-1932.
- South Dakota State College of Agriculture and Mechanics Art, Brookings, 1931-1932.
- State College of Washington, Pullman, 1932 with announcements for 1932-1933.
- Texas Technological College, Lubbock, 1931-1932.
- The Connecticut State College, Storrs, 1932-1933.
- The Pennsylvania State College, State College, 1931-1932.
- Utah State Agricultural College, Logan, 1931-1932.
- Virginia Polytechnic Institute, Blacksburg, 1932-1933.
- West Virginia State College, Institute, 1931-1932.

It was decided to include only schools which offered technical education primarily, and not to include universities and limited branches of universities, such as schools of mines. In the former the offerings in psychology are planned

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* This study was made during the summer of 1933.

largely for psychology majors and liberal arts training. In the latter and other schools of limited technology, psychology is usually not offered. It was also decided to exclude degree courses planned primarily for teacher training, and for education in the liberal arts and sciences.

TABLE I.—Psychology in schools of technology

	Number of technical degree courses.1	Number of members, psychology faculty.2	Number psychology courses offered.	Total quarter hours of psychology offered.3	Number of technical degree courses requiring psychology.
Schools of diversified technology:					
Mean	24.63	2.50	8.72	35.02	5.20
Range	3–47	0–8	1–24	4.5–116.5	0.–15
No.	25	22	25	24	25
Seven largest state colleges: 4					
Mean	38.71	4.57	15.85	62.71	9.86
Range	30–47	3-8	9–24	30–116.5	5–15
No.	7	7	7	7	7

1. The number of degree courses includes the options and outlined majors. All curricula planned primarily for teacher training, music, dramatics, and fine arts (excepting architecture and landscape gardening) were excluded.

2. The faculty includes the teachers of courses in educational psychology, statistical methods, and mental measurements. These courses were included as psychology courses. Three of the 25 schools were not included in this calculation because it was not clear who were primarily psychology teachers.

3. Semester hours were arbitrarily converted into quarter hours by multiplying by 1.5.

4. The state colleges included were Iowa State College, Kansas State College of Agriculture and Applied Science, Michigan State College, Oklahoma Agricultural and Mechanical College, Oregon State Agricultural College (1931-1932), Pennsylvania State College, and the State College of Washington.

RESULTS

The status in general of psychology in 25 schools of diversified technology may be studied in table I. Data are also presented for the 7 largest state colleges. From the mean number of technical degree courses offered by 25 institutions and by the 7 state colleges it is obvious that many different subjects must have been offered and required. The average number of psychology courses offered was considerable. In fact, the number of quarter hours of psychology offered in some of the larger state institutions was greater than expected. The range was from 30 hours to 116 hours, with an average of nearly 63 quarter hours for the 7 state schools. In view of this large offering it is difficult to understand why the average number of degree courses requiring any psychology was only a little over one fifth of the average number of degree courses offered in the 25 schools and only slightly over one fourth for the 7 state colleges. In view of these facts, the large offerings in psychology must have met either the need for electives, or what is more probable, the psychology requirements of the degree courses which were excluded from this study.

The rather low requirement of psychology for training in technology logically raises the question, What psychology offerings were peculiarly related to the different lines of technology? The 22 psychology courses listed in table II were selected because from their titles and descriptions they seemed to be

most directly related to the needs of technologists in agriculture, engineering, commerce, and industry.† In subject matter some of them indicate much overlapping and are therefore not fundamentally different. But each of 15 of these courses was offered in no more than 1 institution. None of them was

TABLE II.—Psychology courses having special significance for students of technology in agricultural, engineering, commercial, and industrial curricula

Courses.	Offerings.		Requirements.	
	Frequency.1	Total quarter hours.	Frequency.2	Total quarter hours.
Abnormal Psychology in relation to Industrial Problems	1	3.0	....	....
Advanced Applied Psychology	1	4.5	....	....
Aesthetics (or Philosophy and Psychology of Art)	3	12.0	....	....
Applied Psychology (general)	9	33.5	6	24.0
Applied (general) Psychology for Electrical Engineers	1	1.5	....	....
Aptitudes Testing	1	3.0	....	....
Business Psychology	2	7.5	1	3.0
Industrial Psychology	3	9.0	1	3.0
Introductory Psychology for Freshmen Engineers	1	4.5	....	....
Laboratory in Industrial Psychology	1	2.0	....	....
Measurements of Personality	1	3.0	....	....
Mental Adjustments	1	4.5	....	....
Mental Hygiene	5	15.0	....	....
Psychological Influences Underlying Economic Problems	1	3.0	....	....
Psychology of Advertising	1	3.0	....	....
Psychology of Advertising and Selling	4	13.5	1	3.0
Psychology of Employment and Personnel Management	4	14.0	1	4.5
Psychology of Safety	1	3.0	....	....
Psychology of Salesmanship	1	3.0	....	....
Psychology of Skill	1	3.0	....	....
Seminar in Industrial Psychology	1	1–6.0	....	....
Vocational Psychology	1	3.0	1	3.0

1. This is the frequency of institutions.
2. This is the frequency of degree courses requiring some psychology.

offered in 5 institutions. Only 1 of them was offered by each of 10 institutions, whereas 11 of them were offered by 1 particular institution. Moreover, it is possible that some of these 22 subject courses may have been only catalogue courses which had been dropped from the class schedules. General applied psychology was the only course that seems to have had much recognition, and it was required in only 6 out of several hundred degree courses.

† Home economics was not included here because the courses having the closest relationship to that field were courses in mental hygiene, child psychology, and psychology of adolescence, which are noted in table IV.

Moreover, the total number of quarter hours for these courses was only 154.5 out of a total offering in psychology of 875.5 quarter hours for the 25 schools.

The reason for the sparse offerings of significant courses may, on the other hand, be indicated in the negligible number of instances in which these psychology courses were required in degree courses. The number of required quarter hours from these significant courses was only 40.5 out of a total of 725.5. Moreover, in most of the specialized degree courses in technology the opportunities for elective courses outside of the field of specilization were frequently negligible, or not clearly indicated, and psychology courses were rarely indicated as options or possible electives. The fact is that many of the degree courses in agriculture and engineering which emphasized administration and management neither required psychology nor suggested it as an elective. It is not inferred from these facts that students should have taken psychology in preference to required technical courses. They may have needed all available time for technical study. But it is clear that many students may have graduated from college with no training in the applied psychology related to their fields of training. From the data in table II it is clear that students could not have elected these courses. They could not have elected what was not offered.

TABLE III.—Required courses in psychology in schools of technology: A comparison of the frequency of requirement with the frequency of offering

Courses.	Required.		Offered.	
	Frequency.1	Hours.	Frequency.2	Hours.
Abnormal Psychology	2	9.0	9	37.5
Advanced Child Psychology	1	3.0	1	3.0
Advanced Educational Psychology	3	9.0	5	18.0
Applied Psychology	8	31.5	9	33.5
Business Psychology	1	3.0	2	7.5
Educational Psychology	19	78.5	8	66.0
Experimental Psychology	1	3.0	12	49.5
General (or Introductory) Psychology	124	483.5	25	103.0
Industrial Psychology	1	3.0	3	9.0
Mental Hygiene	1	3.0	5	15.0
Psychology of Adolescence	6	18.0	4	12.0
Psychology of Advertising and Selling	1	3.0	4	13.5
Psychology of Childhood	3	10.5	4	11.0
Psychology of Childhood and Adolescence	12	37.5	10	36.0
Psychology of Employment and Personnel Management	3	12.0	4	14.0
Social Psychology	5	15.0	14	55.5
Vocational Psychology	1	3.0	1	3.0
Totals	192	725.5	120	487.0

1. This is the frequency of degree courses requiring some psychology.
2. This is the frequency of institutions.

It is also apparent from the data in tables I and II that the psychology courses which were required in technical degree courses had little or no direct application to agricultural, commercial, industrial, and engineering technology. But this is more evident in table III. The psychology courses required most frequently were general (or introductory) psychology, and psychology of childhood and adolescence. Approximately two thirds of the required psychology was general psychology. It seems apparent from this fact that either psychology was taken for its general cultural value, or that general psychology was prerequisite to other psychology courses and that, after taking it, no time remained for applied psychology. This fairly large requirement of general psychology, however, is hopeful. Since general psychology has done that well, what shall we expect in a few years for effective applied psychology courses?

Finally, what lines of technology were really utilizing psychology? The ratios of degree courses requiring psychology to the total number of degree courses offered by the different lines of technology can be determined from table IV. They were approximately .10 for agriculture, .58 for commerce, .02 for engineering, .00 for general applied science (not the regular general science curricula), .83 for home economics, .47 for industrial courses, .25 for pharmacy, and .00 for veterinary medicine. The two lines of technology in which psychology was utilized to a considerable extent were home economics and commerce.

The much greater use of psychology in home economics and commerce was probably due to various causes. First, the success of any technologist in commerce or home economics no doubt depends upon his or her ability to understand and work with other people successfully. The need for psychology training in such fields is more apparent than in engineering or technical agriculture. Second, it may have been that, since much of the required psychology for commerce and home economics, as may be seen in table IV, was directly or indirectly related to education, many students of commerce and home economics no doubt qualified to teach in secondary schools although they did not enroll for the general teacher-training course. Third, home economics and commerce are by tradition and origin more closely linked up with teaching than are engineering and agriculture. Fourth, it is only recently that effective practical applications of psychology have been made to the problems of industry, business and technology. In this connection it should be noted that one finds in these schools of technology very few instances of the stereotyped traditional lists of psychology courses planned primarily for psychology majors. Nearly all of the lists of offerings in psychology include one or more courses designed to meet the need for practical applications.

TABLE IV.—Total number of required quarter hours in different courses in psychology for different lines of technology

	Agriculture.	Commerce.	Engineering.	General Applied Science.	Home Economics.	Industrial courses.	Pharmacy.	Veterinary Medicine.
Number of schools	21.0	20.0	39.0	9.0	21.0	8.0	5.0	9.0
Total number degree courses	202.0	56.0	336.0	12.0	73.0	17.0	8.0	10.0
Degree courses requiring psychology	21.0	33.0	7.0		59.0	8.0	2.0	
Total number quarter hours of required psychology	91.0	182.0	27.0		367.5	48.0	10.0	
QUARTER HOURS OF PSYCHOLOGY COURSES.								
Abnormal Psychology		4.5			4.5			
Advanced Child Psychology					3.0			
Advanced Educational Psychology		9.0						
Applied Psychology	4.5	12.0			7.5	7.5		
Business Psychology						3.0		
Educational Psychology	3.0	10.0			65.5			
Experimental Psychology					3.0			
General (or Introductory) Psychology	68.5	128.5	27.0		219.5	30.0	10.0	
Industrial Psychology						3.0		
Mental Hygiene					3.0			
Psychology of Adolescence	6.0	9.0			3.0			
Psychology of Advertising and Selling		3.0						
Psychology of Childhood					10.5			
Psychology of Childhood and Adolescence					37.5			
Psychology of Employment and Personnel Management					7.5	4.5		
Social Psychology	9.0	3.0			3.0			
Vocational Psychology		3.0						

CONCLUSIONS AND SUGGESTIONS

1. In the schools of diversified technology 80 somewhat different courses in psychology were offered. The number of courses offered in any one school varied from 1 to 24.

2. Most of the psychology courses offered were planned to meet the needs for liberal education, teacher training, and possibly psychology majors.

3. Much work in general psychology was required.

4. The sparce offerings and even more scanty requirements of psychology courses closely related to commercial, agricultural and engineering technology indicated that students had very little opportunity to benefit from the rich new fields of practical psychology now available and closely related to some of their needs.

5. Outside of teacher training, psychology was utilized more fully by home economics than by any other technical line of training. Commerce was second in requiring psychology courses. But only 2 percent of engineering students were required to take any course in psychology, and the opportunities for electing any psychology course in the specialized technical degree courses were frequently negligible. Students of veterinary medicine were equally handicapped. Whatever may have been the causes for the differences in the utilization of psychology by different lines of technical training, the consequences to students remained the same. So-called *common sense* and experience are not sufficient for a technologist who works with, over, or under other people in organized undertakings. Experience may be bad as well as good, and so-called common sense compared with the science of psychology may consist of a hodge-podge from several such superstitions and colorful pseudo-sciences as fortune telling, phrenology, popular psychoanalysis, physiognomy, palmistry, astrology, hardheadness, graphology, demonology, spiritualism, fiction, and table talk. It is bad enough that common laborers in industry may have nothing better. It is very likely, however, that in a relatively short time technologists will have the opportunity in their training to acquire the foundations for a scientific attitude toward the psychological problems they have to meet.

6. The fact that most of the required work in psychology was general psychology suggests the need for an additional year of liberal education so that later applied courses may also be had. Moreover, true economy in education suggests the need for applied courses in psychology that have been built upon the results of a thorough-going job analysis of the technologist's social and technical needs for psychology.

A Factor Unemphasized in Current Theories Regarding the Transfer of Training

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The title of this paper states fairly the writer's intention. There is no thought of presenting a new theory regarding transfer of training, nor even of presenting new data. Our only purpose is to assist in emphasizing what appears to be, until recently, an unemphasized and almost unrecognized factor in transfer. This factor seems to me to be so important for teaching theory that a considerable amount of attention will not be amiss.

Only a brief sketch of past and current interpretations of transfer is necessary here. First is the theory of faculties, in which transfer is assumed to be well-nigh complete. Formal discipline has never recovered from Thorndike and Woodworth's experimentation at the turn of the century. If a faculty were to possess the traits it was supposed to possess, improvement in function must be as large in one field as in another. When this hypothesis was put to the crucial test, nature gave a negative answer. Transfer did not even approach one hundred percent.

As we see it now, the difficulty with the faculty theory was that it assumed transfer to be automatic; dependent entirely upon conditions posed by the environment. Whenever the environment established a condition conducive to transfer, the individual, according to the theory, was supposed to take advantage of it and act accordingly. If the individual had become proficient at reasoning or observing, he would reason or observe well, supposedly, every time the situation was such as to call for reasoning or observation. Both experience and experiment combine to prove that such an outcome is never achieved. Education would be far simpler in many ways if such an hypothesis would work.

In order to replace the faculty theory, Thorndike proposed the theory of "identical elements." Training would transfer when, only when, and in the degree to which, previously learned elements appeared in later situations. This is the reflex arc or S-R bond concept. But here again is an automatic notion of transfer; a notion that the individual will transfer his training whenever the environment establishes a favorable set of conditions. After all, such a theory is fundamentally the same as the faculty theory, for all one needs to do is to divide faculties into sufficiently small units, and behold; one will have identical elements. If transfer does not occur whenever the environment sets the stage (that is, whenever a proper stimulus is applied) then the theory breaks down. And it can be, and has been, easily demonstrated that identical elements do not achieve one hundred percent transfer.

One might argue that the difficulty lies in the fact that we have not yet found the *true* "elements." This may well be, but the search for true elements has been followed persistently for many years and it seems to be getting nowhere. Moreover, physicists and chemists have virtually abandoned the hope of finding ultimate elements and it may be wise for psychologists to do likewise.

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Between 1915 and 1920 the argument waxed hot between Thorndike and Judd as to whether transfer was to be obtained through the agency of identical elements or of generalizations. Judd's dart-throwing experiment seemed to show that mere provisions by the environment of opportunity for transfer was not enough. The individual must also have been given a "generalized" training; that is, he must have been shown during his training that situations seem to work according to discoverable *rules,* and that one must become able to apply the rule (or generalization) before one can take advantage of environmental recurrences and use one's training profitably.

It would seem that the generalization-of-experience theory has some advantage over the identical-elements theory. Long since have Thorndike's pupils reported that he admits the advantage of awareness on the part of the individual of the possibility of transfer. If the individual approaches a new situation with the idea that he may be able to apply ideas, rules, or generalizations previously learned, he will be more likely to interpret the new as being similar to the old, and act accordingly, than if he does not so approach it. This, as I see it, is what training in generalization tends to promote, but does not completely achieve. The question, whether or not transfer will *always* occur after the individual has learned a given principle or generalization, still seems to be answerable only in the negative.

I believe it just as futile to expect a generalization to spring into action whenever the environment sets the stage as to expect such of a faculty or of an "identical element." The difficulty is that the theory of transfer-by-generalizations still leaves the emphasis upon the environment as the dominant, motivating agency; it still interprets transfer as being automatic when the environment sets the stage.

Transfer of a given principle will not be one hundred percent even when the individual understands the principle thoroughly and has applied it often. For example, an object will float in water if its specific gravity is less than the specific gravity of water. This is a phase of Archimedes' principle, and is well understood by many general science and physics students. But how many students will recognize, without being told, that Archimedes' principle applies equally well to objects floating in liquids other than water, and to objects floating in air? How many individuals will solve correctly problems dealing with flotation in air after having received instruction with regard to flotation in water? Not a large proportion; certainly not one hundred percent. Some will catch the relationship immediately; others will see it if given a bare hint; others, if the similarity is carefully explained; and possibly others, not at all. Evidently something more than commonness of elements or appropriateness of generalizations is necessary in order to make transfer dependable. Insofar as this "something" is missed, the transfer-by-generalizations theory is little better than the identical-elements or even the faculty theory.

If I were limited to a choice among the three I would choose the generalizations theory, for it demands more specific training than does the theory of faculties, and is at the same time broader and more educative than the theory of identical elements. But since a generalization may be the identical element in question, the principle of transfer is the same in both cases. This similarity has been noted by Sandiford, a pupil of Thorndike, who claims that both theories amount to one and the same thing. Orata, whose analysis of the literature on transfer of training is probably as thorough and as sound as any in existence, makes the following statement:

"The problem . . . is the ability not so much to generalize and apply as to deal with changing ideals and standards, which means the ability and willingness to change the generalizations made previously. . . . This ability to deal with changing principles or generalizations Judd's theory does not provide for, much less does Thorndike's theory of identical elements." (Ed. Adm. & Superv., 21: 256.)

As a result of Orata's summary of all studies of transfer made between 1890 and 1935, he concludes that—

"Forty-seven or nearly thirty percent show considerable transfer, eighty or nearly fifty percent show appreciable transfer, fifteen or less than ten percent show little transfer, six or less than four percent show no transfer, and the rest which comprise less than ten percent show both transfer and interference. And since interference is indicative of transfer of a negative character, it is safe to conclude that all doubts with reference to the possibilities of transfer of training may be cast away." (*Ibid.*, pp. 242-3.)

But while Orata concludes that "the fact of transfer can no longer be doubted," he also concludes (in the same sentence) that "it is not an automatic process." (p. 252.)

Now, since all of the current theories which appear to assume that transfer will always occur when a particular kind of environment impinges upon a particularly trained individual fail to dispose of the problem satisfactorily, what then? What is the rest of the story? What essential feature of the picture has been omitted?

Bagley seems to hit close to the mark when he introduces the concept of the "conscious deal." He found little transfer of the "ideal" of neatness from class A to other classes, when the instruction was applied to class A papers only. But he found considerable transfer after the teacher of class A had dwelt upon the desirability of neatness in papers prepared for classes other than class A. I have heard Judd speak of the necessity of teaching not only the generalization in question, but also of teaching pupils at the same time that opportunities for applying the generalization will probably be met frequently and that they will do well to look for such opportunities. Thorndike and Gates go on record as follows:

"Studies of the transfer of training also have shown that the methods used in guiding the pupils' learning activities have marked effect upon the degree of transfer. The more clearly the crucial element or fact or principle in a situation is brought to the pupil's attention the more readily the same element or fact or principle may be identified in another situation. . . . If a child observes, despite many differences in details in a new mechanical puzzle, that the vital principle is the same as in puzzles previously solved, the solution is more likely to be achieved than when the common principle is not identified." (Elementary Principles of Educ., p. 104; quoted by Orata, *ibid.*, p. 245.)

The following quotation is from Mursell:

"Our general comment on this (the identical-elements) theory is that identical elements between two situations must always be identities which exist *in the learner's mind.* The mere fact that certain English words are derived from Latin will not guarantee transfer, and indeed will not produce it in any way, unless the identity is perceived and responded to by the pupil. And this absolutely essential recognition, perception, and reaction to identities in various situations, is not a passive affair, which can be counted on to occur." (The Psych. of Secondary School Teaching, pp. 104, 105.)

The point seems to be that individuals must become to a degree conscious or aware of common factors in differing situations—be they elements, gen-

eralizations, rules, ideals, meanings, or what. They must *comprehend* the elements *as* common, the generalization *as* applicable, or the meanings *as* appropriate. They must, somehow or other, *sense* the similarities between later and earlier experiences.

But does this sensing of similarities or relationships need always to be on the level of clear and full consciousness? Apparently not; because many times we act upon the basis of a vaguely felt hunch—intuitively—without being able to state clearly our reasons for so acting. Let me suggest that it seems probable that we transfer previous learning *whenever and wherever* we sense a later experience as being similar, more or less completely, to an earlier one. This "sensing of similarities or relationships" may be vague, or it may reach the level of fully conscious understanding. The more clearly or fully the relationships are sensed or comprehended, the greater is the likelihood of transfer. And conversely; the less clearly or fully the relationships are sensed or comprehended, the less is the likelihood of transfer. It is not enough that the environment set the stage for recognition; the individual is active as well, and the nature of his activity—of his goals and his insights—will be the deciding factor in determining whether or not he will take advantage of the opportunity offered by what confronts him.

Finally, may I point briefly to what this modified view may mean for teaching. If we want our school teaching to transfer in the greatest possible degree to out-of-school behavior, it behooves us to make the student acutely aware of the possibilities of transfer. We must bring him, as frequently as possible, to see the relationships between school and out-of-school situations. In having such relationships repeatedly brought to his attention, the student will become progressively more sensitive to the existence of common or universal features in behavior, more aware of the possibilities of discovering and using such relationships, more likely to discover and apply them for himself, and thus more apt to transfer previous training into new areas of experience. If we would have training transfer in high degree, we must make the student acutely sensitive to the fact that every new experience is likely to have much in common with the old. He must be brought to realize that rules used with success at prior times have likelihood of being successfully used again and again. And he must also be brought to see that new problems may be solved by old rules slightly modified if only the right ones can be found.

One must be able, of course, to see differences as well as similarities; else needless mistakes will be made. No two sets of experiences are ever exactly alike. Life is forever new. Training which will enable one to meet life adequately—that is, training which will transfer—is merely training in being intelligent—thoughtful—scientifically minded.

If we would make training transfer, our teaching must accomplish two objectives more or less simultaneously: first, it must bring the student to understand as many widely useful relationships, principles, or generalizations as possible; second, it must whet the student's realization that his previous training has wide possibilities for transfer, but that transfer is never automatic. It must bring a realization that transfer comes only if and when one senses for one's self that transfer is possible. One becomes able to make the greatest transfer of previous training when and only when, as a matter of habit, one is on the alert to recognize previous relationships, principles, meanings, or generalizations which may be used in the new situations which are always at hand.

A Preliminary Study of the Relative Efficiency of Pattern Repetition vs. Motor Repetition, in the Memorization of Music

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The experiment to be reported was undertaken originally in response to the request of a student in Friends University for help in the memorization of piano music. It was suggested to her that by using her present technique of memorization as a standard, we attempt to discover the relative efficiency of a method depending upon the maturation process. Although she was skeptical of the results, she agreed to experiment.

Alan Irwin, dean of the School of Music at Friends University, kindly agreed to assist, in the capacity of musical advisor. He selected two Bach preludes of approximately equal difficulty, one to be learned in the customary manner and the second to be memorized *without motor repetition.*

The student proceeded to work on the selection for approximately 30 minutes a day. Her method consisted in playing the number over and over again, repeating difficult passages, until she could play accurately and in proper tempo. Then she began to memorize. At the end of 11 weeks Dean Irwin declared the prelude learned. The playing time was 1 minute and 20 seconds, and there were no errors or breaks in rhythm. The student described her memorization as being largely motor—"she had it in her fingers"—and to a lesser extent auditory and visual. She declared that she was extremely tired of the number.

The second prelude was sightread and played in 3 minutes and 20 seconds. There were 5 breaks in rhythm and 22 wrong notes. The instructions were: to work on the music no longer than 15 minutes a day, during which time she was to study the musical form of the composition as a whole, then the form of the themes, then the phrases and finally the chords. Each of the smaller divisions was to be considered in terms of the pattern as a whole. At no time was she to play the piano, but she was instructed to study the music sitting at the piano and to imagine herself playing it. She was to return weekly to play the piece through once, before Dean Irwin and the experimenter. To decrease the subject's skepticism, we described to her the studies of maturation made by Carmichael on swimming in the salamander, by Bird on accuracy of pecking grain with chicks, and by Hamilton on the development of a superior broadjumper through maturation rather than repetition.

The subject studied the form of the music for a total of 50 minutes during the following week. In spite of the fact that she had not practiced playing the notes, her first weekly examination required only 2 minutes and 45 seconds, a reduction in time of nearly one third. Errors and breaks in rhythm decreased proportionately. On the second examination, one week later, the playing time was reduced another third. The subject, by this time, had been won over to the method and convinced of its efficiency, but still doubted her ability to memorize by this technique.

The memorization process required approximately 7 hours, distributed

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over the next 6 weeks. At the end of this time the dean declared her performance satisfactory, said that she had good variety of tone, was sure of her notes, and had nice dynamic control. The subject had played the piece but 9 times.

The subject states: "What seems of great value about this method is that through suspense one is continually motivated. While one is practicing, he actually works much harder, but the time is a great deal less than by the old method. I also believe that this prelude will stick in my memory longer than the other preludes of equal difficulty, because I have a definite *visual* conception of it as well as motor and auditory. During the study periods it was all I could do to keep from putting my fingers on the keyboard, and it became more difficult as I became more familiar with the prelude." It is over two months now since the conclusion of this study, and the subject states that she knows the prelude learned by the second method better than the one learned by the former method and enjoys more confidence and pleasure in its rendition.

These facts, together with the great saving in time, 8 weeks as against 11 weeks, or in actual study time approximately 10 hours as opposed to approximately 27 hours, were so startling that we immediately undertook a more comprehensive and better controlled study along similar lines.

We all felt that the subject might have saved more time if the memorization process had been undertaken sooner. The subject believed that she would have enjoyed the work more if she had been permitted to play the piano to a greater extent during the learning, thus giving better motor and auditory training and a more frequent measure of progress.

It seemed that the experiment might be criticized on the basis of the relative difficulty of the two selections. One might contend, moreover, that there was a possible transfer from the first prelude to the second, so that part of the time saved was not dependent upon method. Another obvious criticism would be that this method might work to advantage for one subject but be less efficient for others. Another anticipated criticism was that while the nonrepetitive method was valuable for an advanced and trained pianist, it was possible that an untrained player would derive more value from frequent repetition.

The solution of these problems was placed in the hands of 16 subjects whose musical experience ranged from one subject with a bare ability to match lines and spaces on the staff with the keys on the piano to one subject with 20 years of playing and piano teaching experience. All were college students.

The subjects were paired by Dean Irwin on the basis of their ability and two numbers of similar difficulty were selected for each pair. The music varied in difficulty from Mozart sonatas to simple hymns and was suited to the ability of the player.

Each subject learned one piece by his usual method and the paired piece with a modification of the already described nonrepetitive method. The subject was instructed to study the form of the selection as a whole and then to differentiate the form. He was then to begin immediately to memorize. When he was certain that he knew a movement, or in the case of a hymn, when he felt that he knew one line perfectly, he was to attempt to play it, without looking at the music. Thus recitation as opposed to study was employed. The superiority of this method in the memorization of music has

been already demonstrated by Kovàcz and Andor Juhàcy. In order to allow greater time for maturation, the subjects were instructed to practice not more than 15 minutes every second day.

Summarizing the results of the study, one inexperienced player required 4 hours and 10 minutes over a period of 3 weeks to learn a hymn by the repetitive method. She played it by lines and never knew until the end of the line whether she could remember the next line. If she forgot a note, she had to return to the beginning and start over. Her memory was largely auditory and secondarily motor. Employing the study-recitation method, she learned a second hymn of like difficulty in 1 hour and 30 minutes over a period of two weeks, a reduction in practice time of almost two-thirds. Her playing was more fluent, her memory more secure. If a wrong note were struck she could visualize the page, correct herself, and continue. She did not become tired of the piece and derived pleasure in the process of translating her mental picture of the music into hand and body movements.

The paired subject learned the first hymn by the new method in 65 minutes, and the second hymn by the repetitive method in 70 minutes. Qualitative data on the learning process were similar to the previous case. The subject believed that the two hymns were of unequal difficulty and that the saving in favor of the new method would have been greater if the two numbers had been of equal difficulty.

The subject with 20 years' experience reduced her learning time from 187 minutes to 95 minutes (almost 50%) when she changed to the new method.

Another experienced player reduced learning time from 130 minutes to 90 minutes when she changed to the new method.

Of all the subjects who have completed the two phases of the experiment, only one disliked the new method. His learning technique involves repeated playing to the point where he knows the melody. By that time he has developed his coördinations, so that he has the piece "in his fingers." He *feels* the music rather than *thinks* it. His objection to the new method was that it involved too much thinking. His learning by the old method required 4 hours and 15 minutes, and by the new method just 2 hours and 10 minutes.

On the basis of the present evidence, we draw the following conclusions:

1. It is possible to memorize piano music without employing the usual repetitive technique.
2. A nonrepetitive method in which the student learned the music in terms of its form proved more efficient in all cases.
    A. The latter method required 7 to 64% less study time. The average saving was 44%.
    B. Five subjects reported that accompaniments of the experimental method were greater interest in the music and superior motivation.
    C. The subjects unanimously agreed that the new method produced a more stable memory pattern than the repetitive method.

These experimental facts support the theory which maintains that learning is a modification of an organism as a whole rather than a limited process localized in a particular part of the learner's body. The subjects were able to play accurately, on their first attempt, without any training of the hands as such.

Under the conditions of this experiment, the music was played only after it was learned. The conditions of learning set up a definite goal—the mem-

orization of a musical selection. The entire period of study was devoted to the differentiation of the musical pattern to the point where each note was perceived in terms of its relation to the pattern as a whole.

The usual repetitive method of learning discourages and blocks the learner since a large percentage of the practice period is devoted to repeating notes and movements previous to the time when the learner's level of maturation has reached a point where these units may be understood.

A crude analogy may help to clarify what is meant. Dynamically, the learning of a musical selection and the solution of a Japanese block puzzle are equivalent. It might be possible to solve the puzzle by a rapid juggling of the pieces, but the puzzle will not be learned until each move is perceived in terms of the ultimate solution. Frequent mechanical repetitions of a sonata may likewise lead the player to the last chord, yet not only fail to increase his insight but actually impede his learning.

The great advantage of the learning method employed in this experiment was that due to the progressive analysis of musical form, each part had meaning at all times within range of the learner's insight. Thus, no meaningless notes were present to confuse the learner and hamper the differentiation of the music.

It is our intention to continue this study by making a further functional analysis of the learning conditions in order to discover optimal spacing for study periods, ideal proportion of study and practice and the relative efficacy of this method of learning for easy and difficult music. We also wish to discover what modifications of the technique are required for children.

It is our belief that due to the nature of the material and ease of measuring progress that music learning furnishes a superior means of gaining a better understanding of the dynamics of learning.

The Experimental Training of a Birth-Injured Child

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One of the most disconcerting of the difficulties confronting the clinical psychologist in evaluating the developmental potentialities of a given child is the uncertainty as to how much of the child's observable and measurable behavior may be regarded as genuinely determined by a level of maturation within the organism and how much of it depends for its character upon a system of previously learned behavior which might have been acquired at any time but could not be acquired without environmental opportunity. The diverse training of identical twins can shed some light on this problem; but to be conclusive, the identical twins must be proved to possess at all times exactly equal maturation possibilities. Also the difference in the training of identical twins becomes in effect a super training of one compared with a normal training situation of the other, which leaves us still much in the dark when we are trying to disentangle the developmental possibilities from the acquired proficiencies of the twin under normal training. The clinician is chiefly interested in children who are like this twin who receives normal training.

Nature sometimes performs an experiment which can be utilized to throw light on this question in the instance of the birth-injured child. In the case of such a child, an injury is inflicted at birth which cripples the child's nervous system from birth without affecting its prenatal potential developmental capacity. At any given time in its life this child's adjustment to its environment can be analyzed and compared with that of the normal child of the same age. Suppose that, following this analysis, the birth-injured child could be given artificially the instrument of learning, by the lack of which he has been crippled, in much the same manner that an artificial leg is furnished for one lacking from babyhood. Further, suppose that, after a period of the use of this compensatory device, the child is again compared to the normal child. We may then know a little more about what portions of the normal child's adjustment must be assigned to each side of the ledger; that is, what portion to developmental factors and what portion to previously acquired behavior patterns. Obviously, to be conclusive, the crippling of the child must be of a critical nature. The question as to what phases of an eight-year-old's language are dependent for their character upon maturation and what depend upon environmental teaching and opportunity cannot be answered satisfactorily by study of a birth-injured child of eight whose injury is so severe that language cannot be acquired, nor by study of one who has spoken with a partly intelligible language training program of whom merely serves to make the language wholly intelligible.

This winter it was my good fortune to have brought into the laboratory, under conditions unusually favorable for study, a birth-injured child of six who showed these critical differences before and after training with regard to motor coördination and speech. All other birth-injured children studied in the laboratory had either been able to walk and use their hands and arms a little, and the training had given them pratically normal efficiency; or they had been so badly crippled that the training, while giving them some use of their bodies, had

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not produced normal efficiency. Similarly, in the case of speech, they had either been using a partly intelligible language which could be cleared up by training and made entirely intelligible, or there was no hope that after training they would be able to do more than make a few sounds to let their more vital wants be understood.

Jack was brought into the laboratory in September, 1935, by Sister Austin, floor supervisor of Wichita Hospital. He was a patient in the crippled children's ward of the hospital. Sister Austin wished to make a study of the child and to carry on a training program with him toward college credit in the course for problem children at Friends University. She was present at all the initial tests and carried on the training program at the hospital, spending two hours a day with the child and bringing him to the laboratory for weekly observation and conference. It is to her remarkably intelligent and conscientious work that I am indebted for the results I am presenting for discussion.

On October 8, 1935, Jack's visual acuity is very defective. His auditory acuity seems to be normal. He is left-eyed and uses his left hand. His speech is unintelligible. Tested with a Stanford-Binet intelligence test, Jack has a basic age of 2, and an I. Q. of 79. Since Jack is under a double handicap of visual and motor disabilities, we were unable to make a test which would give us an adequate idea of his capacity freed from handicap. A Hayes adaptation of Binet gives a basic age of 2 and an I. Q. of 79. In view of the fact that later ages substitute much language achievement for visual achievement in the Hayes test, Jack was still at a disadvantage when taking the Hayes test. A Herderschee test gives a basic age of 2 and an I. Q. of 104. All indications are that Jack's language handicap up to date has been more crippling to him than his motor handicap. He is unable to walk or stand on his feet at all. He uses his left hand; the right is affected by spastic paralysis. He has enough use of it to push things around with it, but does not grasp adequately. He gets his head very close to what he is working with as if he did not see. Eyes do not show proper convergence. Bladder control is at two-year level, with necessity for frequent attention. Lack of control follows it if not given attention at frequent intervals.

Briefly, the account of Jack's response to training is contained in the report of his reëxamination on January 27, 1936. Jack now walks while holding onto objects. During the test period, with one hand he put the other hand on the table and got to his feet. He did one or two tests standing. Then he made his way from table to desk, from desk to crib, and then to door. He gets about by holding onto things with one hand. He can stand alone from 30 to 40 seconds. He has normal use of left hand and arm. He can carry things in his right hand while using his left to hold onto supports. He has a normal grasping motion with the right hand, but the facility is poor. His speech is entirely intelligible, although still faulty in the pronunciation of certain sounds. He has normal bowel and bladder control, and a normal interval. He is learning to read well and has finished a primer. Tested with a Stanford-Binet intelligence test, he has a basic age of four and an I. Q. of 94. He has voluntarily begun to practice to dress and undress himself. His social adjustment is excellent, and his interest in his school work progresses constantly.

The three most outstanding points in the study from a theoretical viewpoint were:

(1) The fact that Jack, who had never had any means of communicating his ideas to others, although he had arrived at an understanding of the language of others, spoke from the beginning in sentences and used a level of language complexity of construction and forms which one would normally expect from a child of his age. Clearly Jack had developed the facility to think in terms of symbols of some sort. When he was able to master the motor coördinations which gave him vocal language, this entire symbolic pattern of his thinking was carried over without loss to the spoken language. The number of words which a child has learned to say and has encountered often enough in his environment to know the meaning of may depend upon his environmental opportunity. Would the constructive level of a child's language equipment be a better index of his developmental level with regard to language? Do we need to develop a measure of this ability to handle complexities of symbolic thought rather than to study so exclusively facility in the spoken word?

(2) The records seem to show that the level of Jack's social adjustment, at the different periods investigated, was not a matter of developmental maturation but of acquisition of motor habits making possible more complex social adaptation. Even physiological functions normally socialized at a very early age, such as toilet habits, remained at the two-year level until Jack achieved an advanced level of socialized adaptations through language and had acquired motor mastery of his environment. Then these physiological functions became socialized without special training methods being used.

(3) The most important factor contributing to this rapid building up of social adaptations was the exploratory facility furnished by the power of locomotion and the command of speech. These facilities may be termed critical, in the sense that they permit social adaptation to environment to progress beyond the two-year level. Without powers of speech and locomotion, a child's social adaptation is likely to remain constant at the two-year level, even though maturation, as evidenced by the capacity for the complex use of symbolic thought, has progressed far beyond this level. The basic age on a mental test may represent this well rounded and stable level of social adaptation. It may be significant that even in the nonlanguage Herderschee test, the basic age was two in September, whereas in January it was lifted to four. The I. Q. on the Stanford-Binet test also passed through a critical point of change. From the point of view of social adequacy, there is a tremendous amount of difference between a rise of fifteen points above seventy-nine and fifteen points above sixty or above one hundred and twenty. The rise which carries a child from below average efficiency into average efficiency occurs at the most critical point possible in the scale of efficiency from the point of view of individual satisfaction and sociological economy. The changes from nonwalking to walking and from unintelligible to intelligible speech seem to be involved in this critical point of rise in efficiency.

A Study of the Relationship Between High School Marks and College Success as Measured by College Marks and Entrance Examinations

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Since the fall of 1924 the Kansas State Teachers College of Emporia has administered to its entering freshmen a battery of examinations. The tests included in the battery have varied from year to year; but, for the most part, they have covered the following fields: intelligence, English, vocabulary, reading, mathematics, and spelling. On the basis of composite scores which the freshmen make, the students are divided into ten groups, known on the campus as deciles. The tests are intended to measure native capacity and previous preparation. An intensive study[1] has been made as to the relationship of performance on these examinations to success in college. The study reported here was begun for the purpose of determining to what extent previous preparation, as measured by high-school marks, is related to success in college, and to what extent high-school marks and entrance examinations can be used to predict college success.

Subjects for the study were, in general, students who entered the Teachers College during the period of September, 1924, to September, 1932, and who continued for at least two consecutive years. Those students who entered in January were not included. Students who transferred work in excess of eight semester hours taken before their first two years at Emporia were excluded, as were those who had completed more than sixteen hours of work at Emporia, through summer school or correspondence, before taking the entrance examinations. In addition, it was necessary to eliminate some of the students because of irregularities in the high-school transcripts. The number of cases included varied from 81 for each of deciles one and two to 174 for decile ten, the total number being 1,204. Four hundred ninety-eight of these were included in the studies for the third year of college; 284 were in school a fourth year; and 341 completed a four-year equivalent either through attendance during the regular academic terms, through summer-school work, or by pursuing correspondence courses. It is readily recognized that, although the method of securing subjects was entirely arbitrary, it can scarcely be termed "unselected" if "unselected" is taken to mean an approximation to the normal distribution curve. The reason is, of course, that mortality among the lower deciles is greater than it is among the higher ones.[2]

In general, the method used was that of intercorrelations, in which high-school marks, college marks, and decile rank on intelligence, English, vocabulary, reading, mathematics, and spelling tests were the variables. For the secondary work one grade average was computed for the entire four-year period. On the college level, however, averages were computed for each year separately, for the first two years combined, and for the four years combined.

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1. H. E. Schrammel and E. R. Wood, "Success and Failure of College Students." Studies in Education, No. 3 (Emporia: the Kansas State Teachers College, 1931).

2. *Ibid.*, ch. III.

In the computation of the high-school grade index all required subjects and all subjects which carried full credit and in which classes met the regular number of periods a week were included except special music courses. For the college averages all subjects which gave credit toward the 120 hours required for graduation were included. Numerical values ranging from .67 for an A+, or a percent grade of 99 to 100, to 5.00 for an F, or a percent grade below 75, were assigned the grades, and the average mark computed on this basis.

Correlation coefficients between high-school averages and entrance examinations ranged from .51 for intelligence to .31 for reading. The coefficient for English and high-school marks was .50, while the coefficients for vocabulary, mathematics, and spelling were .39, .39, and .33, respectively. All of these, however, are significant, since all are much higher than four times the P. E. Coefficients between high-school averages and the composite decile rank ranged from .31 for the 1924 group to .57 for the 1929 group, with a coefficient of .49 ± .01 for the nine years (1924 to 1932) combined. The correlations for the 1924 and 1925 groups were lower, presumably because certain somewhat specific tests in history and civics were included during those periods. It is perhaps worth noting that although different methods of weighting test scores were used at different times after 1925, there was practically no difference in the correlations for the various years.

All of the coefficients obtained between high-school averages for the four years and college averages for the various periods of time were above .60, except that for the fourth year, .52. A possible explanation for the fact that this one was lower is that some of the students lower their grade averages during the senior year by carrying on a more diversified program, participating in more extracurricular activities, and assuming more responsibility for leadership in various organizations, while others who are less interested in extracurricular activities raise their averages through a concentration of work in the fields in which they are particularly interested. The highest coefficients obtained between high-school and college marks were for the first two years combined, .65 ± .01, and for the four years combined, .66 ± .02.

Coefficients of alienation, computed from these correlations, indicate that predictions based upon high-school marks are approximately 25 percent more accurate than pure guess. Coefficients of correlation, computed separately by sex for the freshman year and the first two years combined, were approximately equal. For the four-year period there was a slight difference, the one for the girls being a little higher. For this period the difference in the coefficients of alienation was 6 percent in favor of the girls.

In order to determine the relative value of the various criteria for predicting college success, decile ranks on the various tests, which had already been correlated with high-school averages, were correlated with college averages for the first two years combined; intercorrelations between the various tests were computed; and the regression equation developed. The highest coefficient between college averages and test scores was for English, .54 ± .01, probably because so much of the required work for the first two years is in the English department. The coefficients for intelligence and vocabulary were almost as high, .52 and .50, respectively. The lowest coefficients were those involving reading and spelling. Intercorrelations between tests ranged from .27 ± .03

for vocabulary and mathematics to .68 ± .01 for intelligence and vocabulary. For the most part, intercorrelations involving reading and mathematics were lower than those for the other tests.

Coefficients in the regression equation were as follows: High-school marks, .45; intelligence, —.01; English, .03; vocabulary, .04; reading, .01; mathematics, .02; and spelling, .00.

According to this equation, the only factor which is of any significance for predicting college success is high-school averages. In view of the high zero-order coefficients between certain tests and college marks, and in view of the relationship which has previously been found to exist between performance on entrance examinations and the scholastic achievement of these same college students or of similar groups,[3] such an interpretation is undoubtedly erroneous. The only possible explanation for the low coefficients for the test scores is that there is an overlapping of functions covered by the different examinations. For example, the intelligence test involves certain reading skills; mathematics ability; much vocabulary; and perhaps, indirectly, certain of the abilities covered in an English test. When all of these abilities are held constant, perhaps there is, in reality, very little left to intelligence as it is measured by group tests. It is possible also that the selectiveness of the group may have had something to do with the apparent discrepancies in the equation. Undoubtedly there are many factors besides native capacity and previous preparation which influence college success. It may be that these factors operate more strongly in the case of students who remain in school for at least two consecutive years than in the case of those who drop out sooner. On the other hand, perhaps, since the zero-order correlations are so high between intelligence and the other variables, and since the coefficient for intelligence in the regression equation is so low, it is logical to assume that the intelligence examination is the best single test for predicting success in college. No positive statement of this kind should be made, however, without further experimentation.

In conclusion, it may be stated that:

1. There is a significant relationship between marks earned in high school and scores on college entrance examinations. Intelligence scores show the greatest relationship with high-school marks, while the coefficient between English and such marks is only slightly lower.

2. Although the data are too meager to warrant any sweeping conclusions regarding the weighting of tests, it seems probable that weighting has little influence on the value of composite scores for measuring previous preparation as long as the tests included in the battery are general in nature.

3. For the most part, the coefficient between the composite decile rank and high-school marks is approximately equal to that between intelligence or English test scores and high-school marks.

4. There is a significant relationship between marks earned in high school and those earned in college.

5. There is little difference between the sexes, either in relationship between decile rank and high-school marks or in relationship between high-school marks and college marks. For the four-year period, however, coefficients of alienation based on high-school marks show a difference of 6 percent in favor of the girls.

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3. *Ibid.*, ch. IV.

6. Since there is apparently a great amount of duplication of material covered by the examinations, the regression equation seems inadequate for determining which tests are most valuable for predicting success.

7. Apparently, for purposes of prediction, the average grade earned in high school is highly reliable. The zero-order coefficient between high-school and college marks was $.65 \pm .01$, and the net correlation, when performance on the six tests was held constant, was .46.

The present study is very much limited in scope. It does not take into consideration personality factors, responsibilities outside of school work which the students may be assuming, and, in the case of the students who drop out of school and return later to complete their course, the activities in which the students are engaged during the time that they are out of school. Further investigations should, perhaps, consider these other factors.

A More Extensive Study of the Chemo-Self-Instructional Method in Correspondence Study

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Further data on the use of the chemo-self-instructional method of conducting correspondence courses at Kansas State College seem to justify a further report of the study. A previous study has been reported, (1) but this study covered the use of this teaching device for only a year and a half, whereas data are now presented for a four-year period.

The self-instructor type of lesson calls for little or no writing on the part of the student. For a three-hours college credit course, the student works out ten sets of problems and questions, using ten accompanying self-instructor cards to discover the answers. Each set of questions is made up of a hundred problems or statements with from two to four multiple-choice answers. After studying the assignment through, the student checks his answer to each of the problems on a spot of the self-instructor card. He does this by means of a chemo-pen, or needle, the point of which he moistens with water and inserts through the spot which represents his answer. If the student's first trial answer is wrong, a red color reaction issues from the spot. Should the student secure the red color upon his first trial, he is directed to read again the relevant text material, study more intensely than before, and make another trial answer. He is to continue in this fashion until he secures the blue color reaction, which signifies the correct answer.

Each set of questions and its accompanying self-instructor card covers a definite block of work in the course. The student returns to the home-study instructor his completed self-instructor card, on which are shown the red and blue reaction colors. The instructor then makes a record of the errors and notifies the student of his grade. Students are encouraged to ask the instructor to explain questions that they do not fully understand. This explanation is usually conveyed by means of a personal letter.

During the four-year period, approximately one half of the home-study students in psychology were enrolled in the written-lesson method and the other half in the self-instructor method. Prior to receiving his assignments for the course, each student was required to take two examinations: one, a preëxamination on basic subject matter in the course; the other, a mental test, the same as is used for freshmen at Kansas State College. These examinations were taken under school-approved supervision.

The final examination used for both groups was the Woodworth Psychology Standardized Test, Form A, consisting of 400 objective questions. This test was prepared and standardized by Dr. R. S. Woodworth of Columbia University, author of the textbook used in this study. The scores for standardizing this test were secured from Doctor Woodworth's own classes in summer schools at Columbia University.

The students who used the written method were paired with those who used the self-instructor method in such a way as to give each pair the nearest

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possible equal mental test, percentile ranking and pre-test score. The following are the results of a statistical study of 100 such pairs:

Average difference in mental test percentile ranking, per pair, .053, in favor of the self-instructor group.

Average difference in preëxamination score, per pair, .016, in favor of written-lesson group.

Final examination scores, written method, range, 207-356; median, 289.

Final examination scores, self-instructor, range, 212-372; median, 306.

Average final examination score, written method, 288.1; standard deviation, 4.17.

Average final examination score, self-instructor, 304.4; standard deviation, 4.79.

Difference between averages, 16.3; standard error, 2.67.

Since the difference between the averages shown in the last line above is 2.67 times its own standard error, it may be considered statistically significant.

Resident students at Teachers College, Columbia University, show in their final examination scores, a range of 214-370 and a median of 292 (*2*).

The question may be raised as to the influence of the self-instructor's objective method upon the final examination score, since the Woodworth Standardized Psychology examination is made up entirely of objective questions. It should be pointed out in this connection that the written-lesson method used in this study also made use of a large number of objective questions, so that there was considerable training in objective test procedure with the written-lesson group.

Many comments by correspondence students indicate a strong motivating force in the chemo-self-instructional method. A few of these are given below:

"This new kind of lesson keeps me all keyed up, and once started I can scarcely put it aside until finished."—890 CP 8.

"The self-instructor assignments require more time to work out, make me think harder, but are far more interesting than the written lessons."—858 CP 8.

"This makes five self-instructors I have worked out while convalescing in the hospital following my accident. The way I am, I couldn't have written out a single lesson in long-hand. Besides, I get more fun out of doing these lessons than I would writing them out."—1201 CP 2.

"Handwriting is very difficult for me and I would not be continuing with my fourth course now if it were not for these 'labor-savers.'"—1187 CP 2.

"I learned to examine some of your statements critically and to do some hard thinking for myself."—484 CS 3.

"On some of the questions I have had to read and review two or three pages of material in order to make sure of just one answer, but, believe me, the blue color reaction gives me a kick and more than pays for the effort."—521 CS 2.

"After two or three hours' hard work on one of these 'instructors,' I feel almost mentally exhausted, but I think I'll never forget what I have learned in this way."—389 CP 4.

Certain conclusions may be made on the basis of evidence herein given, together with the writer's observations gained in organizing ten different correspondence courses and conducting, during a four-year period, more than seven thousand lessons by the chemo-self-instructor method. There are a number of outstanding advantages of this method over the usual written-lesson method in correspondence instruction, chief among which are the following:

1. It yields greater achievement in learning the subject matter.
2. It supplies the long-felt need for motivation in correspondence study; for, the student's effort to secure the correct color reaction, his satisfaction in securing the correct response, and his dissatisfaction in securing the incorrect color reaction, compel and hold interest and thus combine to make an impressive learning experience.
3. It saves time and needless effort for both student and instructor.
4. It makes possible the development of the student's own preview of the assignment and therefore develops aims or goals for study.
5. It greatly facilitates the student's comprehension in reading.
6. It makes possible the evaluation of the student's work on an objective basis and enables him to locate his errors.
7. It vitalizes the actual correspondence between the instructor and student.
8. It facilitates learning in that the response to the student's trials in the learning exercise is immediate and vivid as well as being accompanied by a pleasant or unpleasant feeling tone.
9. It permits the use of supplementary teaching devices, and therefore makes it possible for an instructor to use also his own individual methods in teaching.
10. It develops in students the ability to reason, to organize and apply ideas as well as to discover factual material.
11. It saves postage over the written lesson more than the cost of the chemo-self-instructional material.

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A Remedial Program for Probationary College Students

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A remedial program for probationary college students was organized at the University of Kansas by a class of seniors and graduates in the school of education in the fall semester of 1935. Dr. Bert A. Nash was the instructor in the Educational Guidance Course, as it was termed.

In previous years the students enrolled in this particular course did their remedial work with children in the elementary, junior high-school, and senior high-school grades of the Lawrence public schools. There has been felt a need for providing guidance in study habits for the college students who suffer some sort of misdirection, and do not perform according to their maximal abilities. With this end in view the students in Educational Guidance in the fall of 1935 compiled and organized two manuals after a period of careful scrutiny of the literature available on the subject. There were available several manuals which had been developed at other institutions. This type of work has been carried on at Ohio State University, Northwestern University, Stanford University, the University of Michigan, and others. These served as guides, and were very helpful to us in suggesting various techniques to be followed.

It was found that in working toward the organization of two separate manuals the problem could be more adequately treated. The teacher's manual contains suggestions on how to conduct interviews, data to be secured about each case, a brief survey of the reading process, outlines of the major reading difficulties, notes on the technique of proceeding with case studies, specific remedial suggestions for the various reading difficulties, and a selected bibliography on the phases of reading and study. Before attempting any of the laboratory work in the program each student became sufficiently familiar with the content of the teacher's manual to enable him to proceed according to the needs of the case assigned to him.

The student's manual is a guide which contains many helpful suggestions on effective reading and study. It includes a sample time schedule, the organization and following of which are the mainsprings of the entire program. There are included examples of outlining and summarizing. Throughout the manual there is evidence of the concreteness of the program. Rules are simply not enough. There are specific hints and suggestions for reviewing and quiz preparation, and, in general, notes covering the commonly accepted major phases in the problems of reading and study.

During the early part of the semester each student in Educational Guidance was assigned two probationary college students. Interviews were held on the average of twice weekly. It might be added here that college students who fail in more than 40 percent of their course hours are placed on probation, and if they fail to do satisfactory work in the following semester they are temporarily suspended. It was our purpose to salvage as many of these students as possible, especially those who have the mental ability to do sat-

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isfactory work. The probationary students referred to in this report, then, are persons of somewhat higher caliber than most of the failing students.

Following is a summary of the major difficulties of this group of failing students, a brief report of the remedial measures employed, and the significant results:

I. Difficulties: Irregular habits of study, lack of time-schedule, and, in general, a lack of planning.
  A. Remedial measures used:
    1. Organization of a time-schedule with definite periods of study, relaxation, recreation, and sleep.
    2. Providing for study periods as soon after class periods as possible.
    3. Providing for regular review periods.
    4. Providing a regular place for study.
  B. Results:
    1. Students report that a definite schedule gave them more free time than they imagined.
    2. Schedules made possible greater returns for a given amount of time spent in study.
    3. A general feeling of satisfaction was developed in the students since more was accomplished.

II. Difficulties: Poor study habits, lack of outlining and summarizing techniques, faulty organization, inability to comprehend, failure to organize for retention, inability to select main points, inability to adapt reading to the assignment at hand.
  A. Remedial measures used (a detailed diagnosis was delayed until a battery of reading tests was administered):
    1. Practice in outlining, summarizing, condensing for reviews, organizing content, and selecting main points; concrete illustrations of these techniques are provided in the student's manual.
    2. Constant encouragement to use dictionaries, indices, glossaries, and other aids to study.
    3. Suggestions on how to gain the most from a single reading; getting an outline of the material from topical headings, then proceeding to read it carefully, interpreting while reading.
    4. Aiding the student to realize that reading must be adapted according to purpose, difficulty, and time at hand.
  B. Results:
    1. Improvement in outlining and summarizing techniques. Students were asked to bring returned manuscripts with them to interviews.
    2. Students brought condensed review outlines which showed that they were on the right track toward improved study habits.

III. Difficulties: lack of interest in subjects carried, lack of adequate self-confidence, general attitude of indifference.
  A. Remedial measures used:
    1. Pointing out the fact that interest can be developed by spending effort.
    2. Students were made to feel the satisfaction which accompanies success in the interviews.
    3. Following the organization of the time-schedule the students developed a greater sense of responsibility. Some reported, "I know exactly what to do now." "It is easier to study with a plan."
  B. Results:
    1. A more wholesome attitude toward academic work.
    2. Greater coöperation with the tutors.
    3. Greater interest in school work; this result is probably caused, in part, by knowledge of the suspension clause.

IV. Difficulties: Too many social activities, too large allowance from home, operating own automobile, playful attitude.
  A. Remedial measures used:
    1. Time schedules corrected some of the ills.

2. Conferences with parents resulting in students giving up unnecessary items in the allowance, such as giving up automobile and a decrease in month's budget.

B. Results:

1. Work has improved in each case.

V. Difficulties: Lack of adequate self-diagnosis, overestimation of own abilities, carelessness.

A. Remedial measures used:

1. Students were asked to bring in returned manuscripts, and errors were pointed out to them.
2. Tutors were not satisfied with student's reports about their own progress, but conferred with their instructors about the quality of their work.
3. Carelessness disappeared in general when the other factors were treated.

B. Results:

1. Conferences with previous and present instructors of the students were the source of numerous suggestions on how to help bring about improvement in the work of the student involved.
2. In some measure, perhaps not appreciably large, we feel that there is being developed in the student the ability of self-criticism which is essential to effective study habits.

General Results: Even though one cannot hope that a remedial program will salvage all of the cases, such a guidance program is highly desirable, since it does provide some needed direction for the probationary students. Merely warning students that they must do better is not sufficient, and it is certain that a careful, sympathetic diagnosis such as we have attempted in each case will supply the start for academic improvement, though in no case do we hope to undo, during the relatively brief remedial period, habits, attitudes, and ideas toward study which are the by-products of their total school experience.

The four case studies which are included in this paper are representative of the group of failing students from which they were drawn. It will be seen that completely satisfactory results were not secured in all of the four cases reported.

CASE STUDIES

D. G.

This male student is classified as a freshman, seventeen years of age. On the Thurstone psychological test administered last September, he scored at the twenty-third percentile. His percentiles on the Minnesota reading examination administered at the same time were as follows:

Reading vocabulary	9 percentile
Reading comprehension	18 percentile
Reading total	14 percentile

D. G. has no financial worries, does no outside work, and lives in desirable quarters. His health record is of "A" grade, though he is affected by a slight lung infection which tends to fatigue him easily, but is not serious.

The previous semester's record included ten credit hours of "F," two credit hours of "D," and three credit hours of "C." At the present time D. G. is enrolled in thirteen credit hours.

On the following standardized reading tests which were administered, D. G. made satisfactory scores: Monroe standardized silent reading test III, form I; Chapman-Cook speed of reading test; Sangren-Woody reading test.

In a statement consisting of a diagnosis of D. G.'s case we find enumerated

the following difficulties: D. G. was careless in preparing assignments; his diction in written work was faulty, owing to the half-heartedness of his interest in academic subjects. He could not organize material for later recall. D. G. practiced irregular habits of study; had no definite time schedule; stayed up until late hours listening to the radio program, then would make a hurried attempt to complete his class assignment. He did not apply himself to any appreciable degree, and had no definite place or time for study. D. G. has no definite idea of what he wants to do as his life's work. He has shifted from premedicine to geology and later to petroleum engineering. This shiftlessness is not extremely serious, since D. G. is only seventeen years of age.

The following remedial measures were used:

1. A time budget was organized with definite periods for study and review in each subject. D. G. was scheduled to spend only three evenings of the week in study.

2. The tutor provided for exercises in summarizing and outlining. The student was also drilled in condensing content for review.

At midsemester D. G. showed only little improvement. He was reported failing in five credit hours and was graded "D" on the remaining eight credit hours. This case did not respond to the remedial program as satisfactorily as was expected. However, the program has developed self-confidence in this student.

E. W.

This case was a young man twenty years of age, classified as a freshman. His scores on Gates' silent reading examinations were satisfactory in every way. He has a health record of "A."

E. W. has no financial worries. In fact he was allowed over $100 per month, which was much in excess of the amount actually needed. In addition, he was furnished a car, which was detrimental to the welfare of a college student. Another handicap was his living quarters. He lived in a fraternity house.

The previous semester's record included ten credit hours of "F" and five credit hours of "D." His present load is fifteen credit hours.

Regarding a diagnosis of this case, we find enumerated the following difficulties: (1) Never had studied a great deal; (2) Lack of application; (3) Poor organization; (4) Habits irregular; (5) No definite plan; (6) No definite idea as to a choice of vocations.

The following remedial measures were set up:

1. A definite time budget was organized, allowing for definite periods for study, recreation, and social activities.

2. Provision was made by the tutor for review, summarizing, outlining, and taking lecture notes.

At midsemester E. W. had made much improvement. A personal interview with each instructor revealed that he was doing "B" work in all courses.

It should be added that the father was persuaded to take the car away from this student. Also, the purse strings were somewhat tightened up as to the allowance given each month. A handicap which still presents itself is his excessive absence (cuts) from class.

L. S.

This young man is classified as a freshman. He is nineteen years old. The results on the Gates' silent reading examinations indicate that he is above normal intelligence. He has a health record of "A."

L. S. has some financial worries because he must work his way through school. As a result of this requirement, he works nine hours per day for five days a week. His place of residence is desirable from every standpoint.

His previous semester's record included five credit hours of "F" and five of "C." His present load is ten semester hours. A diagnosis of this case revealed the following difficulties: (1) Had never been required to study diligently in high school; (2) Faulty retention; (3) Poor organization; (4) General workmanship poor; (5) Habits irregular; (6) No definite schedule; (7) Too much outside work.

The following remedial measures were used: 1. Definite time schedule for all activities made. (a) Periods of work; (b) Periods of recreation; (c) Periods for study; (d) Periods for review; (e) Correct outline forms; (f) Correct lecture note forms; (g) Review for examinations; (h) Desirable place for study.

2. Regularity of time schedule, which in turn caused this student to regain self-confidence and a knowledge of how to study. He was not reported as failing in midsemester.

H. S.

H. S. is classified as a junior in the College of Liberal Arts and Sciences. He is twenty-one years of age. His health record is of "A" grade. He receives a fairly large allowance from home, and lives in one of the better fraternity houses on the campus.

His scholastic record of last semester showed eight credit hours of "F," five credit hours of "D," and two credit hours of "C." H. S.'s instructors reported that he had more ability than he was willing to employ in his courses. For the second semester his load was cut to thirteen credit hours.

The opinion of his instructors that he possessed at least average mentality was found to be correct. H. S. scored extremely high on the (1) Monroe standardized silent reading test III, form I; (2) Chapman-Cook speed of reading test; (3) Sangren-Woody reading test; (4) Gates' silent reading test, form I, types A, B, C, D.

The difficulties of this student were found to be mainly social in nature. He was participating in a great number of social activities, was receiving too much money from home, and was keeping company with a group of "fast students." The effect of this social maladjustment was that H. S. became unwilling to devote adequate time and energy to his school work and he developed an attitude of indifference toward class attendance and toward getting assignments in on time.

The remedial measures used dealt essentially with providing a definite time budget, with definite periods for study, review, and quiz preparation. One session with the tutor was given to hints on how to prepare for examinations. H. S. was given exercises in summarizing content of subject matter, in making questions to cover the gist of each chapter assigned him, and in condensing material for review.

The results of working with this student were extremely satisfactory. H. S. was reported as doing better than average work at midsemester.

Methods Employed by First-grade Children in Solving Arithmetic Problems

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Typical studies of elementary school children's number ideas have been reported by Buckingham and MacLatchy (*1*), Woody (*4*), and Washburne (*2*, *3*). These studies are to be criticized because they fail to show adequately *how* children deal with number quantities. Measures of counting performances, of knowledge about addition or subtraction facts, of knowledge about fractions do not inform us how children reached their answers. The present investigation has aimed to meet this criticism by permitting the child to choose his own method of identifying, of measuring, and of judging different quantities.

EXPERIMENTAL PROCEDURE

The subject was seated at a desk having a top 21 by 14 inches. A group of unpainted one-inch blocks was placed on a box just to the right of the subject. The experimenter was seated at a table facing the subject and arranged a group of three blocks on the subject's left and a group of two on his right. He was then asked the following question: "Can you get some more blocks from here (the experimenter pointed to the box) and make this pile (two) the same as that one (three)?" Every subject followed the instructions perfectly and continued with the test which consisted in making 49 other combinations *the same*.

There were 48 subjects taking part in the experiment, all of whom were first-grade pupils during the 1934-1935 year at Cordley School, Lawrence, Kan. Three repeaters are included in this group. The chronological ages vary from 64 months to 95 months, with an average of 79 months. A total of 30 were given the Stanford revision of the Binet-Simon intelligence test. The range of I. Q. scores was 85 to 148, with an average of 117.

RESULTS

There were six different procedures adopted by the children. No individual consistently followed one of these methods for the whole period of the examination. Each one, on the other hand, may be described as a typical procedure of at least one individual.

First, pattern method without counting: The pupils using this procedure made two groups of blocks equal in number by making them similar in pattern. Differences of number were reduced at the beginning to differences of form.

Second, pattern method with counting: The children who employed this method placed the blocks into a pattern to facilitate enumeration. Although all the subjects readily employed counting for differentiating groups, the counting method alone, without the use of patterns, proved to be unreliable.

Third, counting method—adding blocks without a complete appreciation of the numerical difference between the groups: The subjects using this procedure first counted the two groups before them. With a difference of two or more, the pupils would estimate the number of blocks to be added to the smaller group. This number of blocks was then added and the groups were recounted. This estimation-and-check procedure was repeated until equality was obtained.

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Fourth, counting method—counting by ones: In this procedure the pupils counted both groups of blocks and then usually added one block at a time to the smaller group while counting up to the number of the larger group. This relatively abstract method of solution offered many difficulties to the pupils.

Fifth, counting method—counting by twos or threes: A few pupils were able to count by twos or threes. This manner of counting the blocks, however, was unreliable.

Sixth, counting method with use of subtraction: Although the most efficient procedure, theoretically, would necessitate the use of abstract number concepts (subtraction), solutions gained in this manner were very few.

Only the most stable children in this test situation used generalized concepts which bear any similarity to those employed on an adult level of abstract thought.

A SUMMARY OF STATISTICAL DATA*

Correlations.		Average scores and measures of reliability.	
r (errors and time)	0.223	Av. errors	8.40
(40 cases)		S. D.	6.01
P. E. (r)	0.101	S. E.	0.95
		Av. time	43.13
		S. D.	9.92
		S. E.	1.57
r (errors and C. A.)	0.086	Av. errors	7.88
(48 cases)		S. D.	6.29
P. E. (r)	0.097	S. E.	0.91
		Av. C. A.	79.00
		S. D.	6.58
		S. E.	0.95
r (errors and I. Q.)	—0.483	Av. errors	7.00
(30 cases)		S. D.	5.69
P. E. (r)	0.094	S. E.	1.03
		Av. I. Q.	117.00
		S D.	13.40
		S. E.	2.44
r (time and C. A.)	—0.133	Av. C. A.	78.43
(40 cases)		S. D.	5.31
P. E. (r)	0.105	S. E.	0.84

* It was possible to give intelligence tests to only 30 of the 48 subjects. Time scores, likewise, were obtained for only a limited number of pupils (40).

The average scores on the basis of errors, time, and chronological age (C. A.), as well as the average I. Q. score, are statistically reliable. The correlation coefficients between errors and C. A., errors and I. Q., errors and time, and, finally, time and C. A., reveal that no significant relation exists between any two of these variables.

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The Schrammel-Brannan Revision of the Army Alpha Intelligence Examination

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The original Army Alpha Intelligence Examination was built and standardized during the World War by a commission of psychologists for the purpose of examining and classifying the recruits. Five equivalent forms, each consisting of eight parts, were used in examining approximately one and one fourth million men in the various cantonments. A complete report covering the construction, standardization, use of the scale, and results which were obtained, is printed under the editorship of Robert M. Yerkes in the *National Academy of Science Memoirs,* volume XV.

ADAPTATION FOR SCHOOL USE

After the World War, the Kansas State Teachers College of Emporia, through James C. DeVoss, then director of the Bureau of Educational Measurements, obtained permission from the surgeon general at Washington to adapt the scale for school use and to publish it. Under the leadership of Doctor DeVoss, grade percentile norms, based on the scores of many thousand students, were computed for elementary school, high school, and college grades. These were published in 1919 in a compact manual of instructions[1] for the test.

In 1927 new percentile grade norms were computed by Wood and Schrammel and published in a revised manual of instructions[2] for the test. These norms are based on the scores of 13,671 subjects. For the same five equivalent forms of this examination with these norms there has continued a marked demand from high schools, colleges, civil service commissions, industrial organizations, and penal institutions for purposes of educational guidance and vocational selection and classification. At present the Bureau of Educational Measurements distributes about 40,000 copies of the test annually.

METHOD OF MAKING SCHRAMMEL-BRANNAN REVISION

The Schrammel-Brannan revision of this examination was undertaken in 1935. The detailed steps of the technical procedure are to be found in an unpublished master's thesis by Christine Brannan in the library of the Kansas State Teachers College at Emporia.

I shall point out a few of the more significant details which characterize this revision. First, the five original forms were administered to college freshmen, and a tabulation was made of incorrect responses and omissions. A sigma difficulty value was next assigned each of the two hundred and twelve items of each of the five forms on the basis of items attempted.

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1. James C. DeVoss, *Manual of Instructions for Use with the Army Alpha Intelligence Tests, Forms V, VI, VII, VIII, IX in Public Schools.* Bureau of Educational Measurements and Standards, Kansas State Normal, Emporia, Kan., 1919.

2. H. E. Schrammel and E. R. Wood, *Manual of Instructions for Use with the Army Alpha Intelligence Test, Forms V, VI, VII, VIII, IX in Public Schools (Revised).* Bureau of Educational Measurements, Kansas State Teachers College, Emporia, Kan., 1927.

It was found that on the original test, which is still in use, the items in the several parts are not arranged in scaled order from easy to difficult. Although a conscious effort was apparently made to arrange the items in scaled order, some marked discrepancies appear. Some items of large difficulty value are placed near the beginning of a part and some of small difficulty value are located near the end. Again some items have become obsolete since their inclusion in the examination. This applies particularly to items of general information in Part VIII. Further, it was found that the time allowed for the various parts is not distributed so well as might be desirable. On some parts nearly all college freshmen and some high-school students are able to respond to all items in the time allowed and have time to spare. On other parts a large majority, if not all of a group, could profitably use more time. Some parts are thus power tests while others are largely speed tests.

On the original test, the giving of the test is also unnecessarily difficult because of the need for timing each part and each item in Part I. The numerous start and stop signals also frequently tend to confuse subjects and occasionally to foster unwholesome emotional disturbances.

NATURE OF REVISED TEST

For the present revision three equivalent forms have been prepared. With the exception of the items for Part I and a few other items in the division of general information, all items were taken from the original five forms. (In order to retain the original number of items of Part VIII, with the obsolete items discarded, three new items had to be found for this part.) For the three forms the items were equated and matched, item for item, for each part according to the sigma difficulty values of the items. The items were so selected that the mean difficulty values of the three forms also were equal. The eight parts of the test were retained. Each of Parts I, III and VI was increased in length by four items. On the other parts, the number of items was kept the same as it is on the original scale. A total of two hundred and twenty items was secured instead of the original two hundred and twelve. Part II, consisting of mathematical problems, was moved from its position to Part VIII, and the intervening parts were moved forward correspondingly.

Part I was modified to facilitate ease of administration. This part on the original scale consists of following oral directions. It is probably the least reliable of the eight parts because of numerous factors which are difficult to control. The more important among these are size of the room and the group examined, acoustic properties of the room, and the examiner's speaking ability.

After a study had been made in respect to the relationship between following oral directions and following printed directions, it was decided to substitute the latter type test for this part.

In the study concerning Part I, five tests were administered to several groups. Three of these tests were Part I of three different forms of the Army Alpha Examination with the regular oral directions. One of them consisted of Part I of Form IX of the Alpha Examination, the directions having been put into writing and placed before the examinee so that it was a reading directions test instead of a listening directions test. For the fifth test, Test No. 39 of the Kuhlmann-Anderson Intelligence Test was used. This test regularly is a reading directions test. The following correlations were obtained:

Between Part I of Form VI and Part I of Form VIII, both oral directions, 87 college freshmen, r = .55 ± .05.

Between Part I of Form VIII and Part I of Form IX, both oral directions, 77 college freshmen, r = .33 ± .07.

Between Part I, Form VIII, oral directions, and Part I, Form IX, written directions, 289 colored men at a CCC camp in Lyon county, r = .65 ± .02.

Between Part I, Form IX, and No. 39 Kuhlmann-Anderson, both reading directions (same colored group), r = .69 ± 02.

Between Part I, Form VIII, with oral directions, and Part I, Form IX, with written directions, r = .56 ± .06.

Between Part I, Form IX, and Kuhlmann-Anderson, Test 39, both written directions, 89 college sophomores, r = .61 ± .05.

Because practically the same size correlations were obtained between the scores on two tests when one consisted of written directions and one of oral directions or when both consisted of written directions, and because each of these set-ups yielded higher correlations than when both tests consisted of oral directions, we felt justified in substituting a test of written directions for the original part of oral directions.

TIME TO ADMINISTER TEST

On the original test the subject works for about 22¼ minutes, and it requires approximately 40 minutes to administer the test. On the new test the subject works for 40 minutes, with very little distraction from beginning to end. As the subject reads for himself the directions for each part as he comes to it, the test is practically self-administering. At the expiration of each 5-minute period, the examiner warns the examinees to proceed to the next part if they have not already done so. An examinee, however, may work ahead as rapidly as he can and return to incomplete items at pleasure. There is no cessation of application on the part of the examinee from beginning to end. The entire examination, therefore, is now a power test. The total time allowed is ample for practically all high school and college students to complete all items they are able to answer. To administer the new test requires not more than two or three minutes more than it does for the original scale, and probably no longer at all if the examiner is unaccustomed to the essential steps involved.

SCORING

The scoring on the original test entails a tedious process which is conducive to numerous errors in scoring and computation of the total score.

On the new test the items are set up to make scoring easy and conducive to greater accuracy. In an experimental set-up it required an average of 7.5 minutes per test to score the original test, to compute the results, and to recheck all work. On the new test the average time per test to perform the same steps was 4.8 minutes, or a saving of 36% of time.

RELIABILITY

For the groups and tests named below, the following reliability coefficients were obtained:

Form A vs. Form B, revised test, in a homogeneous group of college sophomores, .83 ± .02.

Odd numbered items vs. even numbered items on Form A (same group), .88 ± .02.

Odd numbered items vs. even numbered items, Form B (same group), .93 ± .01.

Odd numbered items vs. even numbered items, Form A, junior-senior high-school group, grades VII-XII, .96 ± .006.

Odd numbered items vs. even numbered items, CCC camp, .97 ± .004.

On the original scale with a college freshman group:

Form VII vs. Form VIII, r = .88 ± .01.

Form VIII vs. Form IX, r = .91 ± .01.

NORMS

At present we have percentile norms for grades VII to college seniors, inclusive, and separate percentile norms for student nurses and also for unselected men of several CCC camps. The total number of individual scores is 4,105. We also have percentile age norms based on the scores of 3,565 persons for ages eleven to twenty-five, inclusive. The percentile scores are computed for each fifth percentile. We also have a table of suggested mental ages for ages nine to twenty-one. The mental ages are based on the chronological ages of the persons taking the tests and are not Binet mental ages. As these age scores are entirely for school groups, it is possible that they are too high in respect to the general cross section of the population. A further study is in progress concerning this item.

We are planning to collect many more scores so that both grade and age norms will possess greater reliability and validity.

Although we believe the interpretation of raw scores by percentile scores to be far superior to interpretation by use of intelligence quotients, we plan eventually to provide a complete cross-reference chart so that intelligence quotients may be read off the chart directly when the raw scores and the chronological ages are known. In this manner those desiring to interpret scores into I. Q.'s may do so with ease. We also hope to compile percentile norms for numerous occupational groups so that the test will have greater value when used with occupational groups.

CONCLUSION

In conclusion, I shall enumerate briefly the claimed advantages for this revision of the Army Alpha Examination:

1. The test is practically self-administering.
2. It is much easier to administer than the original examination, and may be used for any size group.
3. It is much easier to score, the scoring is more accurate, and it requires less time.
4. Obsolete items have been eliminated.
5. It is a power test rather than a time test.
6. There are three equivalent forms which make the examination a convenient instrument for retesting.
7. It is as reliable and valid as the original test, which still is a valuable testing instrument.
8. Up-to-date percentile age and grade norms are available.
9. The price is moderate.

The Correlation Between Writing Grade and Maturation

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This is a preliminary study for a master's thesis and is the outgrowth of an experimental study of the handwriting of left-handed children. A remedial program for the "under-scoop and over-scoop" had been planned, but there was no relative measure adequate to determine the comparative progress of the pupils in the various grades. An idea of using a writing scale based on maturation was suggested. This necessitated finding the correlation between writing ability and motor development.

The 440 children at the Franklin Elementary School were given three tests:

1. A simple writing test.
2. Cowan-Pratt Hurdle Jump (a test for maturation of motor coordination).
3. The Parson Manoptoscope test for eyedness.

The age range of the pupils is from 66 months to 173 months, and the grade range is from IB to 6A, inclusive. The writing test consisted of five parts:

1. An original sentence in which emphasis was placed on thought rather than on quality of writing. (This is the usual school situation.)
2. A difficult sentence to copy, entirely new and unfamiliar.
3. A familiar sentence—a test sentence.
4. This familiar sentence in the best possible writing.
5. The same sentence written as fast as possible.

Writing is incidental in the 1B, little drill is given in 1A, and so whatever was written in these grades was classified as "original thought." Thus we have the following five distinct types of handwriting to study:

1. Writing as a vehicle for thought; the writing is automatic.
2. Copying a standard sentence.
3. A drilled test sentence.
4. Writing in which quality is stressed.
5. Writing in which speed is stressed.

Selecting a suitable writing scale proved rather difficult. The various tests analyzed were:

1. Freeman Diagnostic (1914), excellent for diagnosing faults, but not for grading.
2. Ayres Writing Scale (1925 revision).
3. American Handwriting Scale (1929) Paul V. West, School of Education, New York University—too finely graded, having 7 divisions in each of the seven school grades—excellent test—recommended by the A. N. Palmer Company.
4. Zaner-Bloser Scale.

Our choice, through analysis and at the suggestion of Mr. Anderson, supervisor of penmanship of the Wichita Public Schools, was that last mentioned.

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It was devised by Frank N. Freeman, professor of educational psychology at the University of Chicago, and also by the Zaner-Bloser staff. There are seven scales, one for each of the first six grades and one for grades seven, eight, and nine. Each scale is broken into three divisions:

Specimen I—good for the grade with a rating of 90.
Specimen II—satisfactory; 80 rating.
Specimen III—poor; 70 rating.

It is impossible at this time to go into a complete discussion of this experiment. There are at least twenty correlations—correlating each of the five types of writing with motor age, eyedness, chronological age, and grade. However, the most interesting and probably the most important result is the degree of association between the normal writing of the school set-up and motor development or maturation. Then, on finding the correlation between the "original sentence" and motor age, one would expect to find the relationship between writing ability and motor development. This correlation was found to be plus .49—a true correlation and not one due to chance or accident. The standard error of the degree of correlation was .039—indicating, first, that the chances are 2 to 1 that *any* degree of correlation found from similar data would not vary over the amount .039 from the .49, and second, that it is significant, since .49 is over 12.6 times as great as the standard error, whereas only 3 times is adequate.

I believe I may be justified in saying that a correlation of .49 indicates "marked association" between writing ability and developmental level of motor coördination. My authority is Robert Emmet Chaddock, professor of statistics, Columbia University, in "Principles and Methods of Statistics," page 304. He says: "A coefficient correlation of .5 and less than .7 indicates marked association." A moderate degree of association is less than .5 and more than .3.

There are data on 387 children in regard to the original sentence.

The writing grade ranged from 1-70 to 7-80, while the motor age ranged from 4C to 12A plus.

The motor grade is scored on the same basis as used by Arnold Gesell in which the following grades represent the percent of each age passing each test:

C	85-100 percent
B	65- 84 percent
B+	50- 64 percent
A	20- 49 percent
A+	1- 19 percent

The mean of the writing test is 3-90, with 68% of the cases falling between 2-85 and 4-90.

The mean of the motor is 12C—and over 70% of the cases were between 10C and 12A.

The line of estimation showing the regression of writing grade depending on motor age indicates also a definite correlation running from 1-70 at 9C to 6-70 at 12A+. A perfect correlation would have plotted from 1-70 at 4C to 7-80 at 12A+. At a glance one sees these lines are approximately parallel, indicating correlation.

The implications of the findings are numerous. First and foremost, writing

is definitely a psychological problem and as such needs be studied. Furthermore, it presents an almost untouched field of research. It is reasonable, then, if writing is of a developmental nature, to base technique in teaching writing on developmental levels of motor coördination. But do the prevalent methods of teaching follow this idea? Penmanship classes would be organized on the basis of motor age rather than chronological age or school grade. A child, young for his grade, should not be measured according to his grade—nor should the child, immature for his age, be rated according to those of equivalent chronological age. How much of the poor handwriting at advanced age levels is due to practice at an immature level, which establishes the immature pattern to be carried over as a writing habit?

When should handwriting be taught? At what age should the child start? Is the child physiologically mature enough at the second year? From this rough sketch the optimum developmental writing age appears to be nine or ten years of motor age. The child is not physically fit earlier. This explodes the notion that any child can learn to write just by practice.

Important, also, are the selection of writing materials, types of drill, periods and length of practice, and the movements used in writing. Will there not be a differentiation from the grosser motions to the more delicate, from oversized to more refined writing; and does not facility increase as the developmental level of motor coördination advances?

In summarizing, it is essential as well as possible to have a writing scale developed using maturation levels as standards. A satisfactory correlation between motor coördination developmental levels and grades of handwriting makes possible the establishment of such maturation levels of handwriting. The establishment of these maturation standards carries interesting implications, and probably radical changes in the field of handwriting as it is now generally taught. Also the possible effects of neglecting the maturation level of the child in planning the writing program in the school curriculum may be far reaching.

An Attempted Standardization of Tests for Children With Acuity Disabilities

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The wide use of tests and measurements in clinical psychology has led to a rethinking of the ultimate goals which we expect to reach as a result of the diagnostic use of the tests. Mental tests are used to measure the intelligence of the child. This intelligence consists in his efficiency in performing certain tasks, in contrast with the efficiency of other children of his age in performing the same tasks.

From this standpoint, then, it is of vital importance that we know how much that efficiency is impaired by certain acuity disabilities. If a child of six years has had only half vision during those six years, how will his efficiency compare with that of the child who has been stimulated by a full visual field? There is no point in attempting to strike an average, for one individual with a very slight visual disability may be more handicapped than another child who is almost totally blind.

In order to arrive at some measurement of the relative handicap caused by a disability it is necessary to have tests which measure the child's efficiency in the fields where he can be expected to be efficient despite his handicap.

In the Wichita Child Research Laboratory we are constantly finding how inadequate present tests are in measuring the developmental learning of the handicapped child. The tests which we are now attempting to standardize, of course, cannot measure perfectly the loss of efficiency, but they will give us a more reliable method of diagnosing the developmental level of the partial-sighted child, the hard-of-hearing child, or the child with a language disability.

Using the Stanford-Binet test, which is familiar to all, and which is well adapted to ordinary test procedure, as a standard, we have been standardizing the Hayes adaptation of the Binet material for the partial-sighted and the Herderschee test for the deaf on normal public-school children. Neither of these tests has ever been standardized on normal children. Hayes standardized his material on children in the schools for the blind in New Jersey, and while he used the Binet materials he changed the age levels of several of the tests. That is, while the Stanford-Binet requires a vocabulary score of twenty for the eight-year level, the Hayes test requires the score of twenty for the ten-year level. The weights test has been shifted from the nine-year level to the twelve-year level, and tests requiring reading have either been eliminated or revised to fit the needs of the blind or partial-sighted child. In giving this test to normal children in order that the test situation should approach the conditions of the partial-sighted child who would take the same test, each child was blindfolded for the duration of the test. However, even under these test conditions, one must evaluate the qualitative as well as the quantitative difference between the efficiency of the blindfolded child who has had six years of experience with full visual stimulation and an unblindfolded child who has seen only partially or not at all during the six years.

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The tests were given to 60 public-school children, 32 of whom ranged from 100 to 169 months in chronological age, and 28 of whom ranged from 76 to 100 months in chronological age. The range in Stanford-Binet scores was from 80 to 141. The range in Hayes scores was from 77 to 130. In the younger group 6 out of 28 duplicated their Hayes and Binet scores, 6 had scores lower on the Hayes than on the Binet, and 16 had Hayes scores higher than Binet scores. In the older group 2 out of 32 duplicated their scores, 3 had Hayes scores lower than Binet scores, and 27 had Hayes scores higher than Binet. The median difference for the entire group was 4 points. When one takes into consideration the fact that the Hayes test has moved up some of its test situations as much as two years this difference is certainly not alarming. For a child who has made a vocabulary score of 20 on the Binet and passed at the eight-year level does not lose his proficiency when he is blindfolded. But this same score of 20 causes him to pass the Hayes test at a ten-year level. Even the small number of cases tested at the present time then would lead us to believe that the Hayes and Binet tests correlate well on normal children, and thus the Hayes test, used in the laboratory for children whose efficiency has been impaired by poor vision, can give us an adequate measurement of the loss of efficiency due to the handicap.

The Herderschee test was devised by Doctor Herderschee in Amsterdam. Doctor Herderschee has made use of such of the Binet tests as do not require language, and has supplemented these with other tests which would give insight into the intellectual equipment of children who could neither hear nor speak. The test was standardized on the available cases in the deaf and dumb school in Amsterdam. So far as we have been able to learn there has never been any attempt to standardize it in the United States.

This test was chosen rather than a performance test because it is less manual and yet requires no language nor any verbal instruction. Thus the test can be used either for hard-of-hearing children or for those children who have a speech difficulty. There are few speed tests and this gives the child with poor motor coördination an equal chance in the test situation.

The Herderschee test is easy to give and interesting both to the child and the examiner. It consists of form boards and familiar objects, such as keys, marbles, balls, and pennies. There are some drawing tests from Binet and Gesell, and several tests involving insight into problem situations. The test requires from forty-five minutes to an hour to give. In standardizing the Herderschee we told the child that we were going to play games in which we wouldn't talk; he was to figure out what he was to do by the signs we made. Most children were immediately interested and coöperated well. If they forgot and spoke, we shook our heads and refused to answer. This was all very amusing, and consequently rapport was established quickly, and the test situations became in themselves a challenge to the child's ingenuity.

For instance, in the yarn test which occurs in the 4- and 5-year tests, we place the eight balls of yarn in pairs of various colors before the child. We take a red ball in our hand and look questioningly at the child and point to the remaining seven and to the ball in our hand. If the child points to the other red ball we follow up with a gesture of very good, and we repeat with another color. If the child does not comprehend, then we pick up another ball and place it by the red ball shaking our heads discouragingly; then we pick up the other red ball and nod the head affirmatively. This is repeated

with the other colors. Then we proceed with the test proper. We cover the pile of balls with a cloth, take out a ball from underneath, remove the cloth, and look questioningly at the child. The reaction of the child must be correct. He must recall the color of the hidden ball and point out the corresponding color.

Another interesting test is the marble-and-key test in the 6-and-7-year level. We show the child by signs that we wish him to place his hand over his eyes. Then we place a pencil, a block, a key, scissors, a ring, a marble, and a knife in front of the child. In his hand we press another marble. Then we take the other hand away from his eyes, and pressing with one hand the hand which holds the marble, we point out the objects on the table, and look questioningly at the child. The child must now point out in the row of objects the marble as the corresponding object. We follow this with the same procedure with the key. Both results must be correct.

Basically the Herderschee test correlates very well with the Binet. Of the group under 100 months in chronological age, the basic age on the Binet tended to be either 5 or 6. The Herderschee basic age tended to be in the 4-and-5-year level. In the older group the Binet basic age tended to be either 7 or 8, and the Herderschee basic age fell in the 8-, 9-, 10-year group.

In the older group the deviation of Binet and Herderschee scores ranged from 0 to 46 points; in the younger group, the deviation ranged from a score in which the Herderschee test was 12 points lower than the Binet to a score of 63 points higher than the Binet. Five of the younger group had Herderschee scores lower than their Binet scores, and none of the older group. There was one duplicated score in the older group. The median difference for the entire group was 20 points. The Herderschee scores ranged from 68.8 to 189 as compared with the Binet range of 80 to 141.

The individual tests are good, but the entire test consists of only 31 situations, and consequently too much credit is given for the passing of each test. For example, the child is given 6 months' credit for each test passed in the 8-, 9-, 10-year group. It would seem necessary then to add to the Herderschee test in order to make it reliable.

Then, too, because of the small number of tests, the test groups sometimes take in as many as three years as is the case in the 8-, 9-, 10-year group. The next step, then, is to validate the individual tests and rearrange them so that less credit is given for each problem solved.

However, in using the test in the laboratory with children who have a language handicap or who are hard of hearing, we have found it a better measurement of their capabilities than is the Stanford-Binet, since the Herderschee does not presuppose any knowledge of language. In standardizing the test on normal children, we must keep in mind that the normal child has had the advantage of language most of his life, and the test situation does not deprive him of the years of experience he has to his credit even when he is not allowed to speak during the test.

There is much to be done yet in standardizing this test, but since basically it seems to fulfill a real need for a qualitative measurement of the efficiency of a child handicapped by poor hearing or a speech difficulty, and to estimate the amount the handicap affects that efficiency, then it is valuable to the clinician as a differentiating test.

I

A Double Monster Pig—Thoracopagus Disymmetros

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The specimen which we dissected and are herein reporting was sent to the zoölogy department of the University of Kansas by Dr. Mary T. Harman, of Manhattan. The pig had been in preservative for a considerable time, making its dissection difficult, and accounting for any minor inaccuracies in this description. This monster is a male, classified as thoracopagus according to Wilder (*6*), that is composed of two apparently normally formed pigs joined by a union that extends from the umbilical cord (there is only one cord in common for both pigs) up to the base of the neck—some 7.5 cm. in extent. Included in this union is the thoracic cavity and the major part of the peritoneal cavity.

The pig is a double monster. Pig A is in a lower position than Pig B. Pig A is 18.8 cm. long, while Pig B is 21.6 cm. long, from rump to head. However, the heads and legs are of the same length, the heads being 8 cm. long from the snout to the occipital condyles.

The intercostal muscles on the ribs, the skin covering them, as well as the umbilical cord are in common between the pigs. But all the rest of the external structures are separate, that is, the legs, tails, heads and necks are all separate as in normal animals.

In dissecting we made an incision between the nipples starting between the forelegs and working posteriorly, going around the umbilicus and continuing anteriorly up the other side. We examined the internal organs *in situ* at this stage; then we removed the hearts, lungs and tracheae and examined these. Next we removed the entire gastric tract and associated structures intact and followed out the intestine. With gastric tract and the heart removed the rest of the pigs could be examined without further dissection.

All of the main structures of the digestive tracts are normal with the exception of the small intestines. These join a short distance from the duodenum and are united for 87.5 cm., after which there is a bifurcation and the tracts are normal to their respective ani.

What seems to us the most interesting feature in this monster is the development of the bile ducts; each duct enters the stomach instead of the duodenum. This fact proves decisively that this monster could only have lived a very short time, as the alkali of the bile duct would have counteracted the acid of the stomach and normal digestion could not have taken place. There was one hepatic duct beside the normal one to each stomach. In the stomach of Pig A (fig. 4) the extra duct D enters directly into the stomach at a point that is between the duodenum and entrance of the bile duct. In Pig B the extra hepatic duct D enters the bile duct on the normal duct at a point above its entrance into the stomach.

The spleens are unusually large and the mesentary attaching them to the stomach is very short. The other associated structures of the digestive tract are normal with the exception of the livers. These are fused together as were those of all similar monsters about which we read. There are five liver lobes

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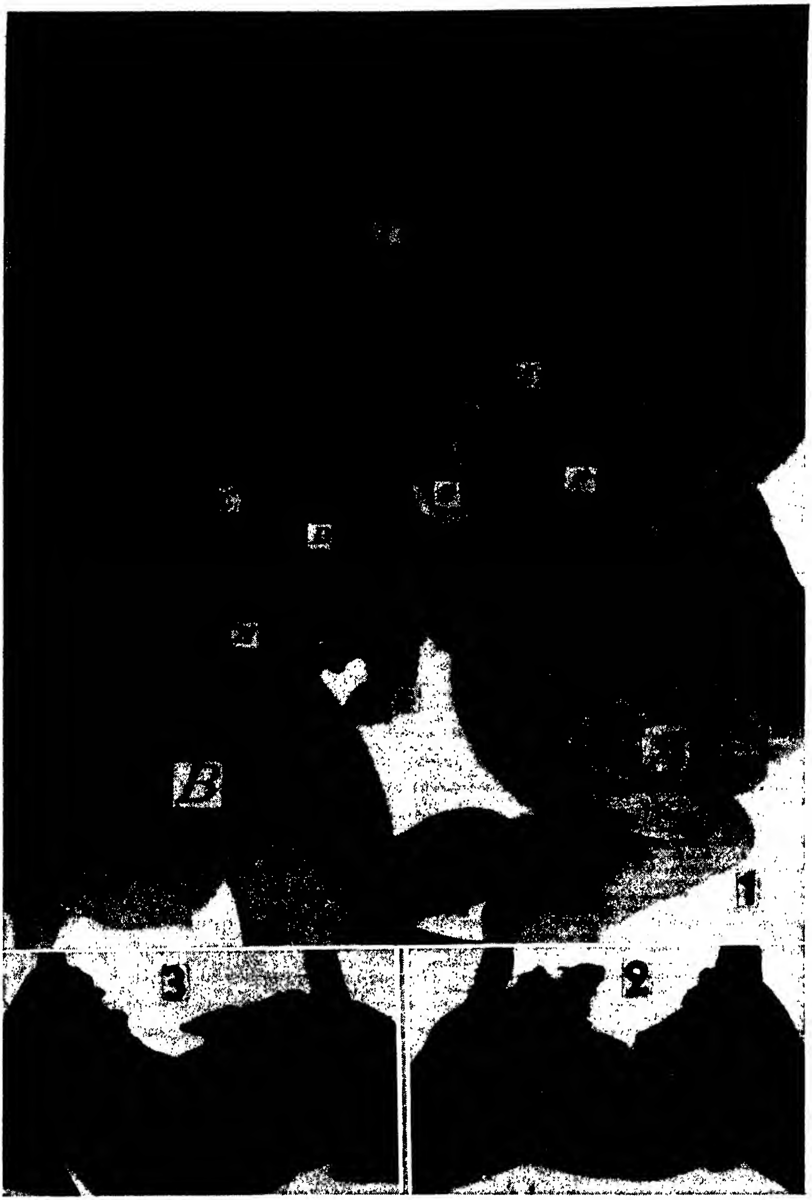

FIG. 1. The monster
FIG. 2. One view of the fused hearts
FIG. 3. The other side of the fused hearts

A. The smaller pig.
B. The larger pig.
C. The fused livers.
D. The line of fusion of the livers.
E. The stomach and blood vessels of Pig A.
F. The spleen of Pig A.
G. The umbilicus.
H. The intestines of Pig B.
I. The diaphram.
J. The heart cavity.

in a normal pig, but there were only six lobes altogether in this monster. In figure 1 the line of fusion can be seen. This is shown by the mesentary, which is attached to what might be considered the center of the fused livers; but it is only on one side of the livers that this may be seen. The portal vein leaving Pig B's side of the liver is larger than that of Pig A.

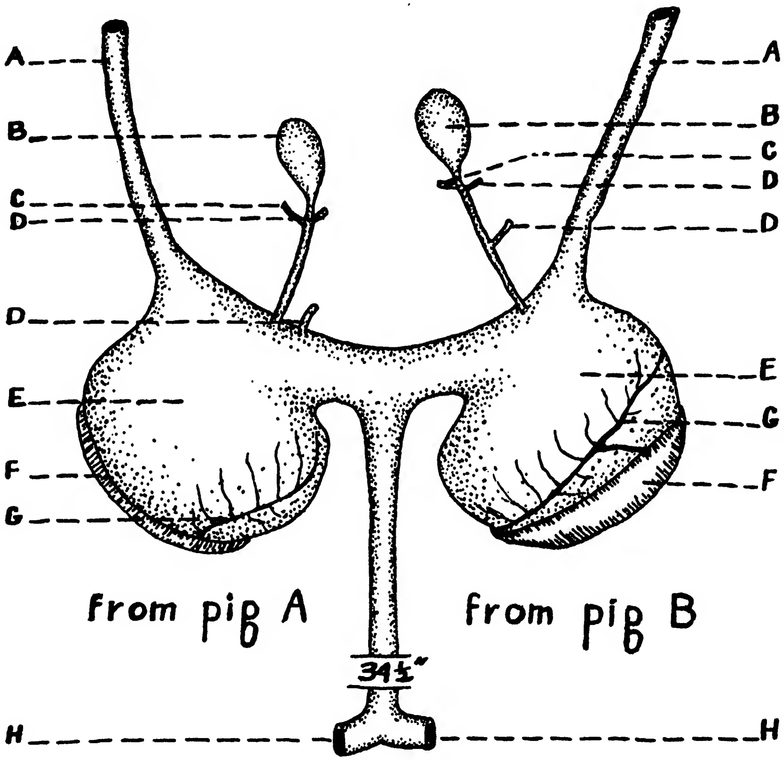

FIG. 4. Diagram of the upper part of the gastric tract.

A. oesophagus
B. gall bladder
C. pancreatic duct
D. hepatic duct
E. stomach
F. spleen
G. blood vessels of stomach
H. small intestine

The two pairs of lungs are in their normal place with respect to their respective animals, and each lung has one large lobe and two small lobes. The lungs were about half the size of a normal pig's at that stage of development. Pig A's lungs were slightly smaller than Pig B's, and none of the lobes were of a normal shape. The diaphrams were joined and the point of union could not be distinguished.

The urinogenital systems are completely separated and independent of each other; each system is completely and normally developed for a pig of that age.

With the exception of the ventricles of the hearts, the circulatory systems

were separate and normally developed. The left ventricles were in place, but the right ventricles were fused together (figs. 2 and 3) in such a way that the monster had only three ventricles—two left ventricles and one right ventricle. The common right ventricle would have had to supply both lungs. The hearts were somewhat smaller in size than for a pig of that development. The exact way of attachment is better shown in figures 2 and 3 than is possible to make clear by any verbal description.

The umbilicus is the last unusual feature to be discussed. As we had mentioned before, there was only one umbilical cord, but this cord contained four arteries—two veins and two ducts, thus appearing to be two normal umbilici enveloped in a common sheath. The nipples are well-developed, eight pairs—four pairs on each side.

Wilder (*7*) first advocated that bilaterally symmetrical monsters are a result of a partial separation of the first two blastomeres, while unequal double monsters are the result of a secondary fusion of two embryos, owing to too great a contiguity. Since that first paper his ideas seem to have undergone some change, and he has come to the conclusion that bilaterally symmetrical beings are developed in respect to their architecture, by means of a mechanism of control inherent in the germ.

According to Wilder (*6*) the degrees of attachment may be classified from Prosopapagus, an organism having one head and two lower sets of extremities, that is, double from the umbilical cord down, to the Urachopagus, an organism having only a part of the umbilicus cord single and part double. Wilder has six main degrees of separation and union between these two types. The monster we are reporting comes under the fifth heading, thoracopagus, a union of two organisms from the umbilical cord up to the shoulder only.

There are two types of symmetries for these double monsters, the case where each part of the monster is symmetrical within itself, and disymmetries where the parts of the monsters are symmetrical to each other. The one concerned in this paper is definitely disymmetrical.

There are many types and degrees of combined systems of internal organs, but we will mention only those that apply to the monster we are describing. Wilder (*6*) discusses a digestive system of duplicate twins that have one head, mouth, and stomach, but the intestines bifurcate and the continuation of the digestive tract is double, two large intestines, etc. The livers he describes as fused, with only one gall bladder. Further, it shows no trace of looking-glass symmetry and is classified as a cephalopagus. A cephalopagus frog studied by Reese (*5*) presents another case of the division of the small intestines.

Condon's double monsters (*2*), two male bodies joined from axilla to hips, was a human; it had a single sternum, umbilicus and one heart. The blood went into the left monster and then to the right monster, making the left rosy and strong, the right blue and weak appearing.

Two separate hearts may be found in the monster that Carey (*1*) studied. One heart was abnormally large and the other was very small and had little or no functions.

The last unusual case that we would like to mention is one described by McIntosh (*4*), a monstrous kitten that had a single umbilical cord which contained two veins and four arteries. This was the only monster we have read of having this type of umbilical cord.

The alimentary tract was distinct in itself. We found references on the alimentary tract (Wilder, *6*) that was single down nearly to the end of the small intestinal tract, then bifurcates, and we found references (Gould, *3*) to tracts that are double down to the stomach and single from there on, but we have found no reference at all on an alimentary tract that had a middle part of the tract single and each end of tract double.

The common bile duct is unusual—we found no references to such a condition. We found one reference to a pig having fused livers (Wilder, *6*) but only one gall bladder.

Now, concerning the heart. We found reference to double monsters with single hearts (Condon, *2*) and with two hearts (Carey, *2*), but apparently the type we described is unique. There is one reference (McIntosh, *4*) to a singularly combined umbilicus.

SUMMARY

The outstanding features of this monster were: (1) the union of the middle part of alimentary canal; (2) the fusion of the right ventricles of the heart, and (3) the unusual position and formation of the common bile duct.

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Elimination of Fat for Potash Clearing[1]

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The potash method of clearing specimens for bone studies has been in use for some time. This method is particularly valuable in studies of bone development or in determining the relation of nutrition to bone structure. The relation of the bones to one another and, also, finer details, can be seen better by this method than is possible by dissection. One disturbing factor is that the large amount of fat in most specimens obscures vision to such an extent that little can be seen in some regions.

No solvent has been found effective in eliminating the masses formed by the combination of the potash with the fat (Strong, 1925). Regarding the extraction of fat from specimens prior to clearing with potash, Dawson (1926) states that leaving the specimens in acetone for a considerable period after fixation in 95 percent alcohol is the most satisfactory method. However, we have found from experience that this method is not entirely satisfactory. All the fat is not removed from larger specimens and there is considerable waste of the solvent, due to frequent changing. For these reasons an apparatus which keeps the specimens in a purified solvent is desirable, and one of this type is described. The effectiveness of various solvents in removing the fat from specimens is also reported.

The apparatus keeps the specimens in a purified solvent by continuous distillation and intermittent siphoning (fig. 1). The solvent in a pyrex flask (A) is boiled in a steam bath (B). The vapor passes up the tube and is condensed in the condenser (C). The extraction cup (D) is made by cutting the bottom from a large round bottle. A tin lid (E) covers the cup and is packed with cloth around the edges (G). A stopper (F) over the lower end of the condenser, fits closely against the lid to prevent escape of the solvent. A piece of screen wire (H) is placed in the bottom of the cup to prevent specimens from stopping up the siphon tube. The cork (J), through which the siphon tube passes, is sealed with gelatin glue. The siphon tube is flattened at (K) so that the surface tension of the liquid will start the siphoning action. Otherwise there is a tendency for the solvent merely to trickle over. The solvent should siphon over every 20 to 60 minutes.

The following method has been followed in preparing the specimen for clearing. Immediately after killing, the hair is removed with sodium sulfide. The specimen is fixed in 95 percent alcohol for at least 3 days. If trichlorethylene,[2] alone or in a mixture, is used as a solvent, it is necessary to dehydrate the specimens before extracting the fat, because water and trichlorethylene do not mix. The fat is extracted by the method of continuous purification of the solvent for five days. In case ether or trichlorethylene, alone

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Trans. Kansas Acad. Sci. 39, 1936.

1. Contribution No. 121 from the Department of Animal Husbandry, Kansas State College.

2. The trichlorethylene used in this work was furnished by E. I. du Pont de Nemours & Company, Wilmington, Del.

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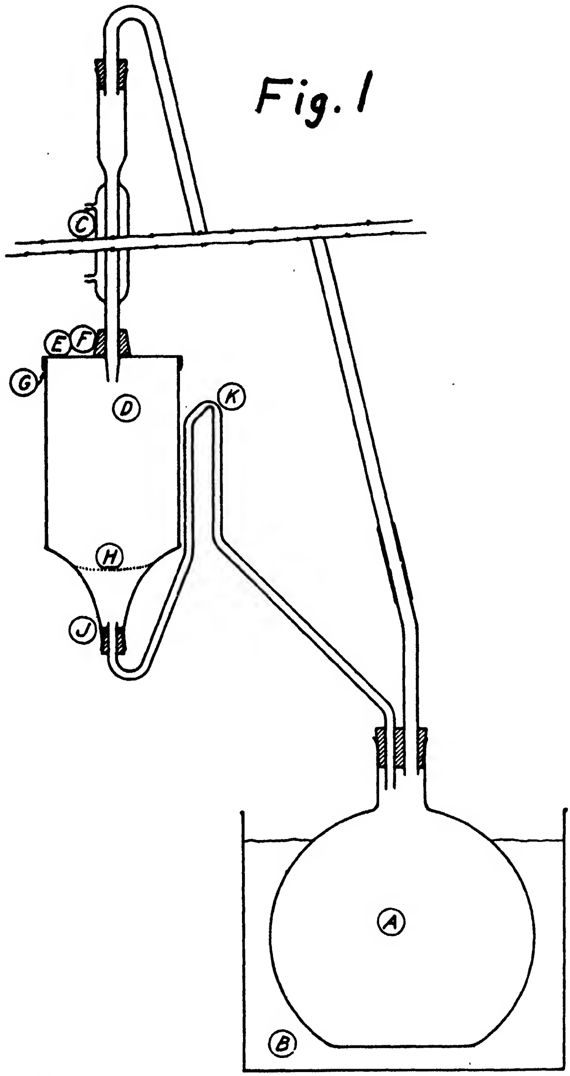

Fig. 1. Continuous distillation, intermittent siphoning, fat extraction apparatus.

SEE PLATE ON OPPOSITE PAGE

FIG. 2. Newborn cat (black) after extraction with pure trichlorethylene. The large amount of pigment prevents light from passing through the body. The bones in the legs do not take a good stain following this method. There is not enough contrast between bone and other tissue.

FIG. 3. Young mouse after ether extraction. Bubbles (b) always appear in the specimen following this method.

FIG. 4. Forty-eight day guinea pig embryo after acetone extraction. All the fat is eliminated and the bones take a beautiful stain following this treatment.

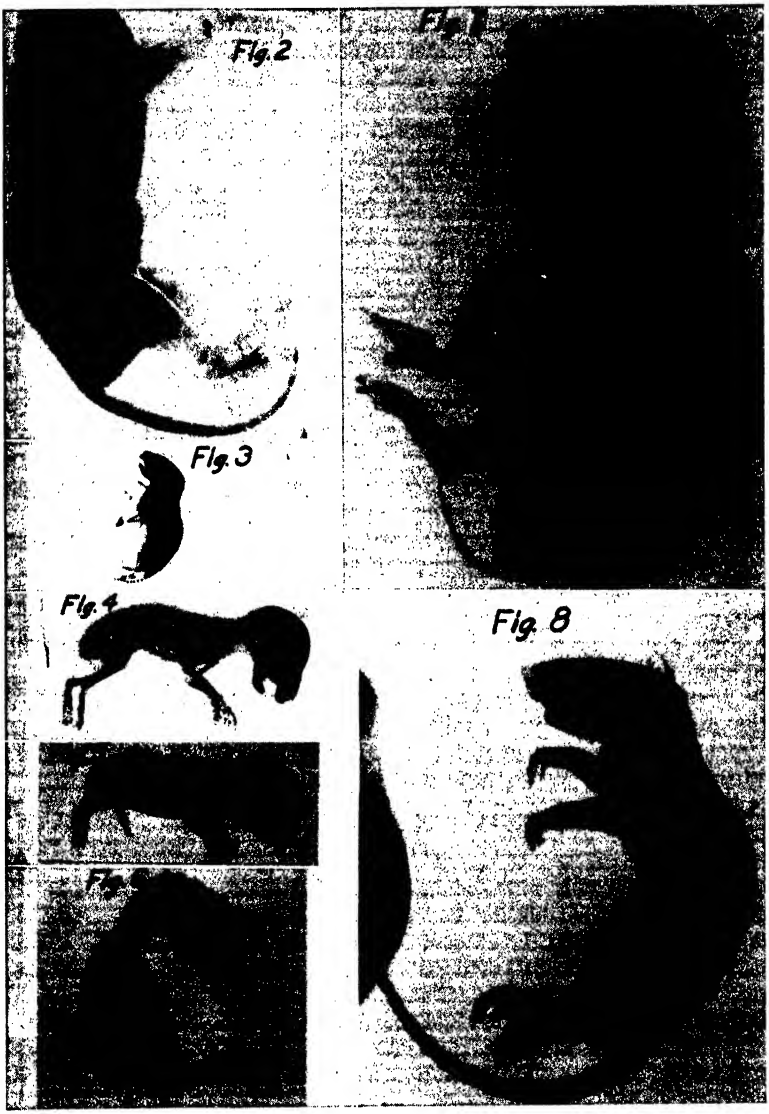

Fig. 5. Guinea pig embryo after extraction with a mixture of trichlorethylene and absolute alcohol (50:50). The fat is all removed, but the contrast between bone and other tissue is not as good as is secured following acetone extraction.

Fig. 6. Seventeen-day chick embryo after extraction with a mixture of trichlorethylene and absolute alcohol (50:50). The fat is all removed and details of bone development are clear.

Fig. 7. Pig embryo cleared without extraction of fat (f). Some of the mass above the shoulders was dissected away.

Fig. 8. Half-grown rat after extraction with alcohol. Parts (f) of the specimen are indistinct, but the large masses are not present.

or in a mixture, are used as solvents, it is best to use alcohol alone during the last day of extraction in order to remove them from the tissue. If they are not removed there is a tendency later toward bubble formation in the tissues.

A 1-percent potash solution is used for clearing. The solution should be changed as often as is necessary in order to keep it clean. The specimens should not be stained until they are well cleared. This is determined by the appearance of the solution. It should remain clear after standing two days. The progressive selective staining of the bones with alizarin gives better results than overstaining, with subsequent destaining by means of acids or sunlight (Dawson, 1926).

Animals having dark pigment in the skin are less satisfactory than white ones, because the pigment cannot be removed and it therefore reduces the visibility.

Specimens in which the fat has not been removed have parts obscured by the masses formed by the combination of the potash with the fat (fig. 7). Alcohol used as a solvent for eliminating the fat is not effective, the specimens still retaining so much fat as to cut down vision in some parts (fig. 8).

Pure trichlorethylene or a mixture of ether and alcohol (50:50) extracts the fat satisfactorily, but specimens, after extraction by either of these solvents, do not clear well. Small bubbles develop in the specimens extracted with the mixture of alcohol and ether (fig. 3). No satisfactory method has been found for removing ether from the specimen. The bones do not take the stain well following pure trichlorethylene extraction (fig. 2).

Acetone is only partially effective in removing the fat from larger specimens, but gives good results in the smaller ones (fig. 4). The bones take a good stain following this treatment.

A mixture of trichlorethylene and absolute alcohol (50:50) gives good results in all specimens (fig. 5). This solvent is more satisfactory in removing fat from chick embryos than any that has been tried. Chicks, after this treatment, show every detail in bone development (fig. 6).

STEPS TO BE TAKEN IN PREPARING SPECIMENS FOR BONE STUDIES

1. Remove the hair with sodium sulfide immediately after killing.
2. Fix in 95-percent alcohol for at least three days.
3. Extract the fat by the method of continuous purification of the solvent, using acetone or a mixture of trichlorethylene and absolute alcohol (50:50). About five days are necessary. If the second solvent is used, the specimens must be completely dehydrated and the solvent must be eliminated with absolute alcohol after the extraction.
4. Clear in 1-percent KOH solution until the specimens do not color the solution on two days' standing.
5. Stain with alizarin in 1-percent KOH, making the solution a light-wine color with alizarin, until the bones are well stained. Do not allow the other tissue to stain. About 12 to 24 hours are sufficient.
6. Transfer to a mixture of 20-percent glycerin and 80 percent of the KOH solution. Leave for several days.

7. Gradually increase the glycerin content until the specimens are in almost pure glycerin.
8. Mount in pure glycerin.
9. For mounting in museum jars, tie the specimens in place with silk thread to sheets of celluloid.

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Speed of Toxic Action of Different Concentrations of Phenol on Simocephalus

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This paper presents a series of experiments on the relation between the concentration of phenol in water solution and its toxicity as measured by the speed of killing the small crustacea *Simocephalus serrulatus* (Koch) and

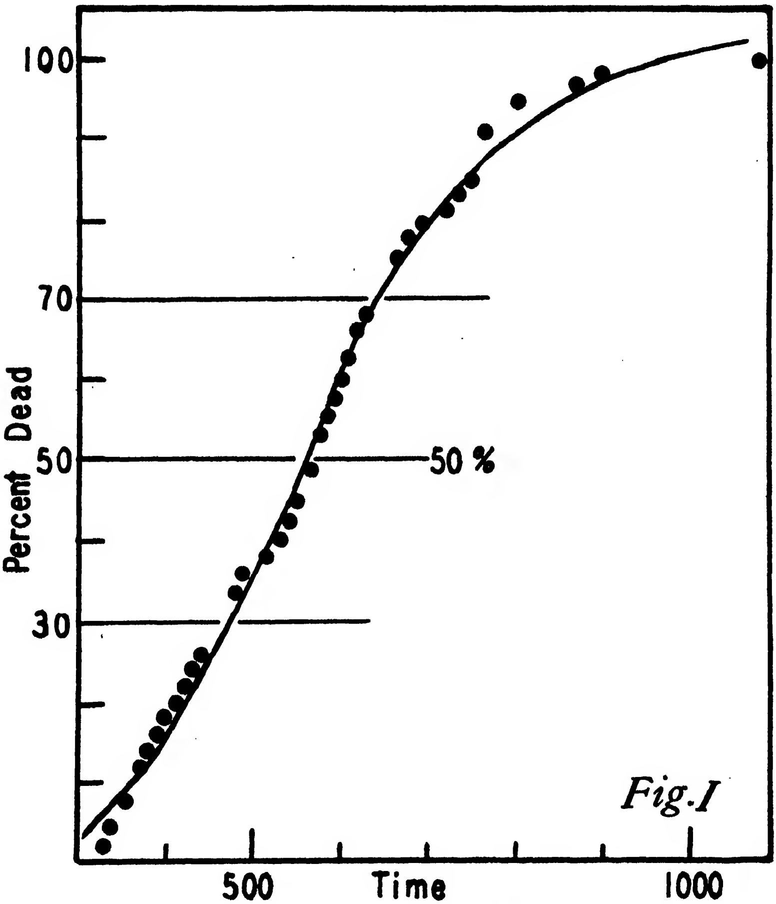

FIG. 1. Killing curve for 0.1% phenol. 50% line intersects curve at 570 seconds.

S. vetulus (Muller) immersed in the solution. A series of concentrations was used, ranging from 0.032 percent to 8.5 percent. The concentrations were chosen so as to give even intervals when plotted logarithmically. Some of the animals were collected from Lake Okoboji in northwestern Iowa, and

from still pools in the Neosho river system in Kansas[1] and some were cultured in a large aquarium in the laboratory. Preliminary observations showed no significant differences between individuals of the two species or from the different sources. Between males and females and between young and adults there were differences similar to those cited in a previous paper (*1*) though not enough were tested to give accurate comparisons. All animals used in this series were adult parthenogenetic females. In most cases the temperature was 25°C.; data from a few performed at 23 and at 27 were corrected for plotting by using a Q_{10} value of 1.84, determined by a preliminary experiment with a concentration of 0.1 percent phenol over a temperature range of 20 to 28°C. This is very close to the value obtained in a previous similar experiment (*2*). The killing time was obtained by direct observation under a low-power microscope. The time taken was from the moment of immersion in the poison solution to the last observable body movement.

When the total numbers of animals dead at successive time intervals are plotted as ordinates against the corresponding times as abscissas the familiar sigmoid curve is obtained. Figure 1 shows the curve for the 0.1 percent concentration. The time value at which this curve intersects the 50 percent line may be taken as a measure of the killing time for the concentration in question. If the curve is symmetrical this time will coincide with the average time obtained arithmetically.

The following table shows the data for the entire series:

RELATION BETWEEN CONCENTRATION AND KILLING TIME

Concentration of phenol in percent.	Average killing time by calculation.	50 percent killing time determined graphically.	Temperature, Centigrade.
8.5	46.7	47.5	27
5.6	82.5	81.5	23
3.2	98.6	100	25
1.0	198	....	25
0.56	249	246	25
0.32	395	387	25
0.10	583	570	25
0.056	1,647	1,320	23
0.032	2,979	2,830	27

It will be noted that the time obtained by calculating the average and that derived from the intersection of the 50 percent abscissa and the killing curve are close together except in the case of the 0.056 percent concentration. In this case there were a few extremely resistant individuals, which perhaps raised the average unduly. The average for the 1 percent solution is based on only 11 specimens, too few to permit drawing a smooth curve accurately enough for graphic determination of the killing time. The num-

1. It may be a point of ecological significance that neither species of Simocephalus has been taken in these pools since the drought of 1934, although both were fairly common up to that time.

ber of individuals for each of the other concentrations was about 50. All killing times are given in seconds.

Concentration effects are commonly studied by plotting the logarithm of the killing time against the logarithm of the concentration. For convenience in comparing this study with previous ones the killing rate is used instead of the time. This is the reciprocal of the killing time multiplied by the factor 10^4. To avoid negative logarithms and to keep the slope of the lines in conventional form the reciprocal of the concentration is used. The result is a pair of intersecting straight lines shown in figure 2. This may be expressed by the familiar equation:

$$\text{Log } S = \log K - k \log (1/C), \text{ or } S = KC^k,$$

where S is the killing rate, C the concentration, and K and k constants. Log K then represents the distance from the origin to the intersection of the concentration curve and the zero ordinate and k the slope of the curve. This is the Ostwald (*7*) equation, which has proved very convenient for practical purposes and seems to have a good theoretical foundation.

There is a break in the concentration-toxicity relationship, occurring at about 0.075 percent. The weaker concentrations used are less toxic than extrapolation from the region of the stronger ones would indicate. Thus there is a critical concentration above and below which the effects of changing concentrations are different. Such breaks have been obtained by Hartmann (*6*) for the effects of various salts on the crustacean Bosmina, by Powers (*8*) for various salts on fishes, by Campbell (*4*) for arsenic on the silkworm, by the present author (*2, 3*) and his assistant for mercuric chloride on the crustacea Simocephalus and Daphnia, by Gauss (*5*) for quinine hydrochloride and mercuric chloride on Paramecium, and others.

It is obvious that the straight-line relation between log rate and log concentration cannot continue indefinitely. When a certain dilution is reached the solution is no longer able to kill at all, the rate at that point being zero. Further dilution will not change this rate. A concentration is also reached above which any further increase will not result in an increased killing rate, due to a minimum diffusion time, certain latent periods, and the like. This is the maximum killing rate for the particular poison and organism under consideration. In the present case the saturation point of phenol is reached before the straight-line relations fail at the high concentration end.

Between the above limits, breaks indicate differentials due either to differences in the chemical composition of the poison above and below certain critical concentrations or to differences in the responses of the organisms above and below certain threshold values. Gauss writes (*5*) "each of the lines (as in figure 2) has its own slope of exponent of intoxication. The most important is the fact that when we pass from one group of concentrations . . . to another, at a certain point the exponent of intoxication changes abruptly. This suggests that here we may have to do with two different processes causing death."

Phenol was chosen for the present experiments because it is a relatively simple compound with a low dissociation constant and fairly high degree of toxicity over a considerable range of concentration, without complications due to hydrolysis. It should therefore be a good substance to test differential responses on the part of the organism.

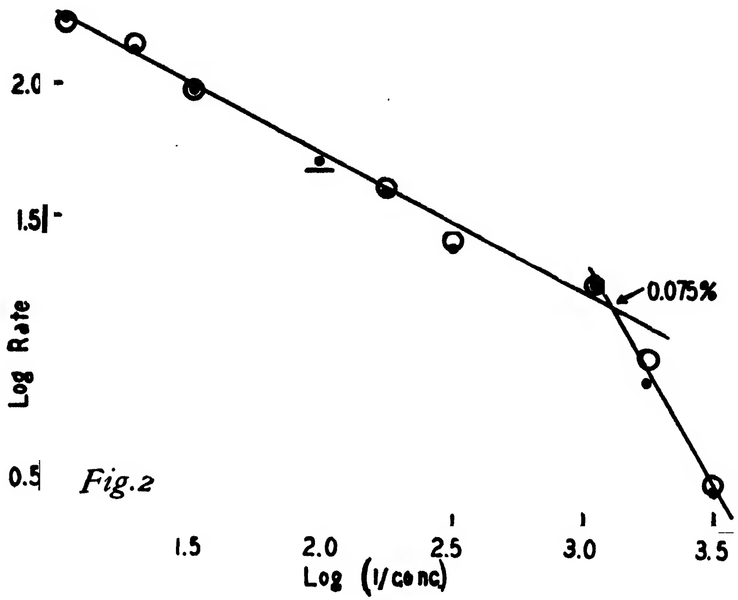

FIG. 2. Relation between killing rate and concentration. Open circles represent rate for 50 percent dead, determined graphically. Closed circles rate determined by the calculated average. No graphic determination for underlined point due to too small number of individuals.

SUMMARY

The killing curve of *Simocephalus serrulatus* and *S. vetulus* with phenol in water solution in concentrations ranging from 0.032 percent to 8.5 percent is a typical sigmoid curve.

The speed of the toxic action varies as a constant power of the concentration, the power being higher for the lower concentrations. The logarithmic graph is a pair of straight lines intersecting at about 0.075 percent.

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A List of Amphibia and Reptiles of Chase and Lyon Counties, Kansas

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The following list is not complete, but it seems desirable to place it on record at this time because there are practically no herpetological field data available from this area.

The terrain considered of these two counties varies considerably, ranging from Flint Hills prairie through flood plains to wooded hills. The Flint Hills occupy most of Chase county and extend into the southwest and northwest corners of Lyon county. The wooded hills are in the northeast part of Lyon and are for the most part in the Osage watershed. In central Lyon county and northern Chase county lie the flood plains of the Neosho and Cottonwood rivers, which join in east central Lyon. A small section to the extreme south of the area belongs to the Verdigris watershed.

The Flint Hills are devoted almost exclusively to grazing. The flood plains are farmed intensively. Northern Lyon county has general farms and many large pastures.

Except in the flood plains there are many springs, from which small streams make their way through rocky gullies. It is among these that the most successful collecting has been done.

Forty-four species and subspecies have been taken. Unless otherwise specified, each form has been found in both counties.

AMPHIBIA

1. *Necturus maculosus maculosus* (Refinesque), Mud puppy, rare since 1934 drought.
2. *Ambystoma taxanum* (Matthes), Texas salamander, Lyon, fairly common.
3. *Ambystoma tigrinum* (Green), Tiger salamander, Lyon, occasional.
4. *Bufo americanus americanus* Holbrook, American toad, fairly common.
5. *Acris gryllus* (Le Conte), Cricket frog, abundant.
6. *Pseudacris triseriata* (Wied), swamp cricket frog, Lyon, common.
7. *Rana catesbeiana* Shaw, Bullfrog, common.
8. *Rana pipiens* Schreber, Leopard frog, common.
9. *Microhyla olivacea* (Girard), Narrow-mouth frog, Lyon, only one specimen.
10. *Bufo woodhousii woodhousii* (Girard), Rocky Mountain toad, occasional.

LIZARDS

1. *Crotaphytus collaris collaris* (Say), Collared lizard, abundant in Chase, rare in Lyon except southwest corner.
2. *Holbrookia maculata maculata* (Girard), Spotted lizard, common in Chase and southwestern Lyon.
3. *Phrynosoma cornutum* (Harlan), Horned "toad," common in Chase and southwestern Lyon.
4. *Ophisarurus ventralis* (Linné), Glass "snake," Lyon, 4 specimens.
5. *Cnemidophorus sexlineatus* (Linné), Six-lined race-runner, Lyon, 1 specimen.

6. *Leilopisma laterale* (Say), Ground lizard, Lyon, 1 specimen.
7. *Eumeces fasciatus* (Linne), Blue-tailed skink, scorpion, fairly common.
8. *Eumeces obseletus* (Baird and Girard), Sonoran skink, common in Chase and southwestern Lyon.
9. *Eumeces septentrionalis septentrionalis* (Baird), Northern skink, Chase, 3.

SNAKES

1. *Carphophis amoena vermis* (Kennicott), Worm snake, Lyon, common.
2. *Diadophis punctatus arnyi* (Kennicott), Ring-neck snake, common in Lyon, occasional in Chase.
3. *Coluber constrictor faviventris* (Say), Blue racer, abundant.
4. *Elaphe laeta* (Baird and Girard), Rat snake, Chase, fairly common.
5. *Elaphe obsoleta obsoleta* (Say), Pilot black snake, Lyon, fairly common.
6. *Pituophis sayi sayi* (Schlegel), Bull snake, common.
7. *Lampropeltis calligaster* (Harlan), Blotched king snake, 2 specimens from Chase, fairly common in Lyon.
8. *Lampropeltis getulus holbrooki* (Stejneger), Speckled king snake, salt-and-pepper snake, 5 specimens from Chase, 2 from Lyon.
9. *Lampropeltis trianglum gentilis* (Baird and Girard), Red king snake, milk snake, Chase, 4 specimens.
10. *Natrix grahamii* (Baird and Girard), Graham's water snake, Lyon, occasional.
11. *Natrix rhombifera* (Hallowell), Diamond-black water snake, Lyon, fairly common.
12. *Natrix sipedon sipedon* (Linne), Common water snake, abundant.
13. *Natrix transversa* (Hallowell), Blotched water snake, abundant.
14. *Tropidoclonion lineatum* (Hallowell), Lined snake, 2 specimens from Chase, common in Lyon.
15. *Thamnophis radix* (Baird and Girard), Plains garter snake, 1 specimen from Chase, fairly common in Lyon.
16. *Thamnophis sauritis proximus* (Say), Ribbon snake, Lyon, fairly common.
17. *Thamnophis sirtalis parietalis* (Say), Red-barred garter snake, abundant.
18. *Tantilla gracilis* (Baird and Girard) Miter snake, Chase, fairly common.
19. *Agkistrodon mokasen* Beauvois, Copperhead, Lyon, 2 specimens.
20. *Sistrurus cantenatus edwardsii;* (Baird and Girard), Massassauga, common in Chase and southwestern Lyon.

TURTLES

1. *Chelydra serpentina* (Linne), Snapping turtle, common.
2. *Terrapene ornata* (Agassiz), Box turtle, common.
3. *Chrysemys bellii bellii* (Gray), Bell's turtle, occasional.
4. *Pseudemys elegans* (Wied), Cumberland terrapin, Lyon, occasional.
5. *Amyda spinifera* (Le Sueur), Spiny soft-shelled turtle, occasional.

A Study of the Blood Picture of Rabbits Subjected to Various Types of Smokes

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In a paper presented before the Kansas Academy of Science last year, Garlock[1] reported the results of determinations of the blood picture of rabbits subjected to cigarette smoke. In her investigation it was found that "Rabbits treated with cigarette smoke showed a marked increase in the hemoglobin content, the red cell count and the percentage of pseudo-eosinophiles and a notable decrease in the total white cell count and the percentage of lymphocytes." Since her work was confined primarily to a study of the results of subjecting rabbits to cigarette smoke only, the question naturally arises as to whether these findings are to be accounted for on the basis of the action of cigarette smoke, or if the same results might not have been obtained by subjecting animals to any other smoke under similar conditions. Since her report apparently is also the only available one bearing on this particular type of problem, further study seemed warranted in order to verify her conclusions. It was with these thoughts in mind that the present study was undertaken.

Our problem, therefore, is confined to an attempt to determine the results of subjecting rabbits to smokes of several different materials.

The blood pictures used in this study include the hemoglobin percentage. the red and the white cell counts, and the differential white cell count.

MATERIALS AND METHODS

In this experiment marihuana, standard brands of cigarettes, smoking tobacco, ground coffee, and white cigarette papers were used. The marihuana was the dry powdered plant which was mixed in various proportions with smoking tobacco. Because of the difficulty in securing this product, we were not able to obtain enough to use it alone; furthermore, we were never able to get enough to make as many tests as we had hoped to complete. Healthy, normal, adult rabbits of both sexes were used in this work. Inasmuch as these rabbits were raised in the laboratory, they were accustomed to frequent handling and consequently showed no evidence of being excited by the handling necessary in the experimental procedure. This condition may be of considerable importance, since some investigators have claimed that the excitement of rabbits during the process of making blood pictures is sufficient to bring about a material change in the normal blood picture. However, this is denied by certain other investigators.

At the beginning of the investigation blood pictures of several rabbits were made to determine whether our results compared favorably with those reported by other investigators. The animals were fed in the evening subse-

Trans. Kansas Acad. Sci. 39, 1936.

1. Garlock, Mary. 1935. A study of the blood picture of rabbits subjected to tobacco smoke. Transactions Kansas Academy of Science.

quent to the time of making all the tests, for it was felt that this procedure would give results less influenced by certain changes normally associated with the digestive processes.

Standard methods were used in determining the blood pictures. The Sahli method was used to determine the percentage of hemoglobin, while the red and white cell counts were made on the improved Neubauer counting chamber. The differential white cell counts were made with Wright's stain and the cells were classified into five groups, viz., lymphocytes, eosinophiles, monocytes, basophiles, and pseudo-eosinophiles or neutrophiles.

The steel chamber in which the rabbits were subjected to smoke was not air tight, but it was closed with a comparatively tight-fitting door. At one end, near the top, was a small opening for ventilation and at the other end, near the bottom, was another small opening through which the smoke was introduced. The lighted cigarette was held in the smoke vent of the chamber by a glass tube then covered with a glass cylinder to which a tube was attached for introducing air which forced the smoke into the chamber. After smoking each rabbit separately the chamber was well aired before being used again.

Each rabbit was subjected to the smoke of one cigarette for each of the three one-hour periods daily and was removed from the chamber for one-hour rest intervals between the smoking periods. The blood picture was determined immediately before the first and immediately after the third period of smoking on each consecutive day during the test, since it was felt that this procedure would give a more accurate picture of whatever changes might occur as a result of the treatment.

In subjecting the rabbits to the smokes of cigarette papers, ground coffee, marihuana, and smoking tobacco alone the procedure was much the same as for cigarettes, except that the materials were placed in a clay pipe which was thoroughly cleaned after each test. The pipe was fitted into a glass cylinder to which was connected a tube for introducing air into the burning material and forcing smoke into the chamber. Smoke was driven into the chamber until it came out of the ventilator, thus indicating that the compartment was completely filled.

To determine whether the handling and confining of the animals in the chamber were responsible for the results observed, we treated a control series in exactly the same manner as the smoked series, with the exception that no smoke was introduced into the chamber.

RESULTS

In presenting the results of our study we have prepared the following composite table (table I). In the column headed "Number of tests" the first figure represents the number of animals used, and the second figure indicates the total number of tests made on such animals.

In the above table it will be noted that there is a consistent increase in the hemoglobin content of the blood of the animals in all of the test series (cigarettes, tobacco alone, cigarette papers, marihuana, and ground coffee) ranging from 9.0 to 17.7, whereas no such increase is seen for the control series. Likewise, there is a rise in the total number of red cells and white cells in all of the test series, without corresponding increases in similar counts made on the control series.

TABLE 1.—Average results of blood pictures of rabbits

SERIES.	Number of tests.	Homoglobin.	Red cells.	White cells.
Cigarette	a 9-54	73.3	6,360,000	11,180
	b	88.2	6,480,277	11,670
	c	+14.9	+120,277	+490
Cigarette papers	a 5-23	72.3	6,536,000	8,883
	b	90.0	6,900,000	10,350
	c	+17.7	+364,000	+1,467
Tobacco alone	a 7-42	71.3	6,256,664	12,757
	b	82.3	6,415,813	13,674
	c	+11.0	+159,149	+917
Coffee	a 4-16	71.4	6,451,850	10,659
	b	84.7	7,431,250	11,584
	c	+13.3	+979,400	+925
Marihuana	a 1-4	69.5	6,085,000	6,975
	b	78.5	5,945,000	8,262
	c	+ 9.0	+140.000	+1,287
Control series	a 4-16	79.3	6,835,437	9,924
	b	79.2	6,682,500	9,325
	c	− 0.1	−152,937	−599

a, Before treatment; b, after treatment; c, difference.
* Called neutrophiles by some investigators.

subjected to different kinds of smoke

Differential count.				
Lympho-cytes.	Pseudo-eosinophiles.*	Eosino-philes.	Mono-cytes.	Baso-philes.
55.1	40.7	2.1	0.7	1.5
32.2	62.6	2.21	0.8	1.5
−22.9	+21.9	−0.11	+0.1	0.0
59.3	37.3	1.6	0.3	0.8
25.6	70.3	1.6	0.3	1.2
−33.7	+33.0	....	....	+0.4
54.3	40.4	3.1	0.6	1.3
31.7	63.9	3.1	0.3	0.9
−22.6	+23.5	....	−0.3	−0.4
61.5	35.2	1.4	0.9	0.9
42.4	53.2	1.8	0.4	1.2
−29.1	+18.0	+0.4	−0.5	+0.3
59.2	36.2	1.7	1.2	1.2
52.5	44.7	2.0	0.2	0.4
− 6.7	+ 8.5	+0.3	−1.0	−0.8
65.4	31.8	1.4	0.5	0.7
62.0	35.2	1.2	0.4	0.8
− 3.4	+ 3.4	−0.2	−0.1	+0.1

The determinations of the percentage of the pseudo-eosinophiles shows a marked increase with all the test series and only a slight increase (3.4) with the control series.

In contrast to all the increases just noted there is an evident decrease in the percentage of lymphocytes. This decrease is very marked except for the tests with marihuana. The small decrease (6.7) for the latter may or may not be characteristic of results of the use of the smoke of this material because of the small number of tests which we were able to make.

The same may be said of the smallest increase (8.5) in the percentage of eosinophiles following the use of this material.

Because of the smallness of the numbers representing the percentage of monocytes, eosinophiles and basophiles, and because of the unequal chance of finding the true number of any one of the respective types of cells when examining a given slide, the changes noted may or may not be significant.

While the above results show that the blood picture of rabbits subjected to the smoke of white cigarette papers alone corresponded closely to those of animals exposed to the other types of smoke, it was interesting to note that a very striking difference in the general condition of these animals occurred, in that four of the five animals so treated died during the testing period or soon thereafter. The remaining one was seriously incapacitated and has remained so to the present time—a period of five months. This condition appeared to be associated with the respiratory function in as much as the animals all showed grave difficulty upon inspiration. To date, we have not investigated the mechanism of this condition. None of the animals used in the other experiments showed any signs of being incapacitated in any way.

SUMMARY

1. Rabbits subjected to the smoke of cigarettes, white cigarette papers, tobacco alone, and ground coffee showed a significant increase in the hemoglobin percentage, pseudo-eosinophiles, red cells and white cells with a marked decrease in the percentage of lymphocytes.

2. Four tests made on one rabbit subjected to the smoke of marihuana-tobacco mixture in the proportions of 1:2 and 2:3, showed an increase in hemoglobin percentage, white cells, and pseudo-eosinophiles, with a decrease in the number of red cells and lymphocytes. Since, however, the number of tests made with this material was relatively small it is possible that these results might not be significant.

3. Of the five animals treated with the smoke of white cigarette papers alone, a striking difficulty, apparently of respiratory origin, was encountered, which resulted in the death of four of the five animals during the testing period or very soon thereafter. The remaining one was severely incapacitated.

4. A control series handled in exactly the same manner as the several test series, except that the animals were not subjected to any smoke, showed small and inconsistent differences between the tests made before placing them in the chamber and those taken immediately after removing them from it.

CONCLUSION

1. Our results indicate that in general the blood picture of rabbits subjected to the smoke from cigarettes, cigarette papers, ground coffee, marihuana-tobacco mixture, and tobacco alone, are very much alike.

2. The physiological effect obtained with cigarette papers appeared to be much more serious than those of the other smokes used, as four out of the five animals treated died during the time of testing or soon thereafter.

3. The reported findings of Garlock are confirmed, except that we observed a definite and consistent increase, instead of a consistent decrease, in the white-cell count of rabbits subjected to the cigarette smoke.

18—6031

Length of Life for Animals: With Food, But Without Water; and With Water, But Without Food

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Priestley's statement in 1774 for mice living on food, but without water, indefinitely suggested to the author the undertaking of this work. The following statement was taken from volume I in Priestley's Experiments:[2] "I found to my great surprise, in the course of these experiments, that mice will live entirely without water; for though I have kept them for three or four months, and have offered them water several times, they would never taste it; and yet they continued in perfect health and vigor. Two or three of them will live peaceably together in the same vessel; though there was observed one instance of a mouse tearing another almost to pieces when there was plenty of provisions for both of them."

The author of this paper and his assistants found the opposite in their experiments relative to animals with plenty of food but without water. Three sparrows were placed in a cage with grain (wheat) but without water, as follows: One (male), June 12-14, 1934; one (female), June 14-16; one (female), November 15-17; and in every case they lived but two days. To see if they would die upon being placed in the same cage, one was placed in a cage June 12, 1934, and another February 22, 1935; in both cases they were kept there for a week with food and water without any noticeable ill effects.

Five experiments were run with sparrows with water but without food during March, 1936. Two of these lived one day and twenty hours; two lived two days; and one, two days and seven hours. The average time for these was about the same time as for those without water but with food.

A similar experiment was run with a flicker with food but without water June 20-22, 1935, in which the bird lived two days. A pigeon lived from July 5, 9 a.m., to July 9, 11 p.m., four days and fourteen hours. One rat lived from June 12 to June 16, four days, with oatmeal but no water; and another rat from July 2 to July 4—both having been two days under the same conditions. The weather was extremely hot during these experiments. Another rat with food (oatmeal) and water continued from June 12 to June 28 (sixteen days) without any noticeable ill effects, and increased in weight from 16.847 to 21.928 grams.

The life of mice without water but with food was longer than that of birds and rats. One mouse lived from May 10 to May 31, 1934, twenty-one days, during this time losing in weight from 16.958 to 9.735 grams; one lived from September 27 to November 4, thirty-eight days, during this time losing eleven grams in weight; and the third from January 3 to January 9, six days, without water. These mice were fed common oatmeal which had not been dehydrated.

Trans. Kansas Acad. Sci. 39, 1936.

1. Gladys Riddell, Martha Hursh, and Raymond Lichty.

2. Priestley, Joseph. Experiments and Observations on Different Kinds of Air, vol. I. p. 18. 1790.

A series of experiments with white mice from September, 1935, to March, 1936, eight of which were run without water but with food (oatmeal) gave results as follows:

Number 1 lived 34 days, September to October.
Number 2 lived 9 days, November.
Number 3 lived 11 days, November.
Number 4 lived 7 days, December.
Number 5 lived 8 days, January.
Number 6 lived 6 days, February.
Number 7 lived 6 days, February.
Number 8 lived 7 days, March.

Female and male mice were alternated in the experiments. Mouse number one that lived thirty-four days was fed uncooked common oatmeal. The others in the list were fed dehydrated oatmeal, which no doubt accounts for a shorter period.

Eight experiments with white mice without food but with water were as follows:

Number 1 lived 6 days, September.
Number 2 lived 4 days, November.
Number 3 lived 6 days, November.
Number 4 lived 5 days, December.
Number 5 lived 5 days, January.
Number 6 lived 5 days, February.
Number 7 lived 3 days, February.
Number 8 lived 7 days, March.

The average time for the seven without water was 7.7 days, and the average time for the eight without food, 5.1 days. The general opinion that animals can live longer without food than without water was proved by these experiments to be erroneous. The mice in these experiments were weighed every day. The average daily loss in weight was more for those with water than those with food. Their daily loss in weight was usually more the first few days than the last few days that they lived, but there was a gradual loss in weight until the end.

Two guinea pigs, about half grown, were put under test March 9, 1935, one with food and water, and the second with food but no water. The one with food and water gained in weight from 419.5 to 446.1 grams in twelve days. The one without water lost in weight from 416.8 to 271.9 grams in thirteen days. They were weighed every day, and the one without water gradually lost in weight every day until it died. The time it lived without water was fourteen days. The one without water was very quiet during the fourteen days of the experiment, while the one with food and water was very active all the time. The food for these animals was mostly oatmeal and alfalfa, but occasionally carrots, celery tops, and corn.

As stated above, Priestley found that one mouse would tear another in pieces while they had plenty of food. With our experiments we found that they would do this when they were without food, but never when they had sufficient food.

The Amphibians and Reptiles of Mammoth Cave National Park Proposed

CLAUDE W. HIBBARD, Resident Wildlife Technician, Mammoth Cave National Park Proposed

INTRODUCTION

Mammoth Cave National Park, composing a portion of Warren, Barren, and Edmondson counties, is located in the west central part of Kentucky in the upper Austral zone.

The park is divided by Green river. The area south of Green river does not have a natural surface drainage. The surface water runs into numerous sinkholes, where it is carried away by subterranean streams to Green river. On this side of the river we find many valleys and hollows, over which numerous sinkholes occur, making the floor very rough. In places the valleys have not completely collapsed, leaving small hills in the path of the streams. Between the valleys are the large flat ridges, some of which are still covered with hardwoods. Many natural ponds are created in the valleys by sinkholes becoming stopped up and not allowing the surface water to run off. Springs are not abundant on this side of the river. Their course is very short, as they emerge and flow only a short distance before sinking. Many caves occur in this portion of the park.

The cover types found on the south side of Green river are based upon "Forest Cover Types of Eastern United States" (Journal of Forestry, 30, 1932). The types are as follows: Sugar maple, post oak, blackjack oak, scarlet oak-black oak, southern red oak-red oak, beech-sugar maple, beech, and river birch-sycamore. The above types of forest cover 13,762 acres, as compared to 12,476 acres which are undergoing natural reforestation or are being cultivated at the present time.

The area on the north side of Green river presents a different type of country, as well as a different flora in many of the smaller and more isolated localities.

This area has not been eroded and cut down into the limestone as has that south of the river. The few caves and sinkholes on this side are small. The valleys are followed by surface streams, at least during the period of high water. A few of the streams flow over the surface throughout the year, though many originate from large springs which flow until a point is reached where the limestone is exposed, where they sink and appear a short distance below, only to disappear again.

The cover types found on the north side of Green river are as follows: hemlock, blackjack oak-post oak, scarlet oak-black oak, southern red oak-scarlet oak, chestnut oak, Virginia pine, eastern yellow poplar-white oak-red oak, chestnut, beech-sugar maple, beech, river birch, wintergreen, cucumber Magnolia (*Magnolia acuminata*), *Magnolia macrophylla, Magnolia tripetala* and mountain laurel (*Kalmia latifalia*). The above types of forest cover 12,425 acres, as opposed to 8,683 acres which are undergoing natural reforestation or are being cultivated at the present time.

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Although this list of amphibians and reptiles may not be complete, the new records and distributional data increase the herpetological knowledge of this region.

I am greatly indebted to Dr. Edward H. Taylor and Mr. Hobart M. Smith, of Kansas University; to Dr. Doris M. Cochran of the National Museum, to Mr. Charles F. Walker and to Dr. Frank N. Blanchard, of the University of Michigan, for the identification of specimens. The work was done under the auspices of the Wildlife Division of the National Park Service.

The notes in the list following were compiled from work in the Mammoth Cave National Park from June 1, 1934, to August 31, 1935. All forms listed are represented by specimens in the collection at the park unless otherwise stated.

Species marked by asterisk (*) are those not recorded by Bailey in "Cave Life of Kentucky," published in *The American Midland Naturalist,* 14:385-635, 1933.

1. *Necturus maculosus maculosus* (Rafinesque), waterdog. This record is based upon specimens caught by fishermen in Green river, where it is abundant. Mud puppies are caught in early spring on trot lines and bank lines. They are considered poisonous by the "natives."

*2. *Cryptobranchus alleganiensis* (Daudin), hell-bender. Abundant in Green river. As many as four or five are taken from one trot line during the months of March and April.

3. *Triturus viridescens viridescens* (Rafinesque), common newt. Abundant near woodland ponds and on wooded slopes. Courting, mating and laying of eggs were observed June 11 and 12, 1934.

*4. *Ambystoma jeffersonianum* (Green), Jefferson's salamander. Only one specimen, NPS No. 82, has been observed. A large adult was taken February 27, 1935, when an old stock pond was drained during road construction.

5. *Ambystoma maculatum* (Shaw), spotted salamander. Common. Eggs were first observed March 4, 1935. As many as fifty egg masses were found in a pond 30 feet in diameter. Laying was interrupted March 6, 1935, because of cold weather, but after a rain on the night of March 10, it was resumed and continued throughout the month of March.

*6. *Ambystoma opacum* (Gravenhorst), marbled salamander. Common. Observed under old logs or debris in old fields or in the woods on the ridge tops.

*7. *Ambystoma tigrinum* (Green), tiger salamander. Common, mainly during breeding season around ponds. Observed breeding on the evening of March 5, 1935.

8. *Plethedon dorsalis* (Cope). Abundant, chiefly on wooded ridges, slopes and old broom sedge (*Andropogon virginicus*) fields. Not observed until October 6, 1934, at which time they were abundant on the wooded ridges under leaves, logs, and debris. At the approach of cold weather they disappeared until early spring. They were first observed March 4, 1935, along the edge of a sinkhole, which had grown up to sedge grass. While turning rocks along this slope I uncovered 16 in an old rotten mouse nest. By the last of April they had disappeared, apparently going deeper into the ground.

9. *Plethodon glutinosus* (Green), slimy salamander. Abundant, from the cave entrances to the top of the wooded ridges, always under logs, rocks or leaves in moist places.

*10. *Pseudotriton montanus montanus* (Baird). Dr. E. R. Dunn reports one specimen (M. C. Z. No. 5639) from Edmonson county, Kentucky, in his book "The Salamanders of the Family Plethodontidae," 1926. I did not find this species.

11. *Pseudotriton ruber ruber* (Sonnini), red salamander. Common. Over 60 were removed during August from a spring at CCC Camp No. 1. The females were heavy with eggs.

*12. *Eurycea bislineata bislineata* (Green). Not common, but found along the spring-fed tributaries of Wet Prong Buffalo, First Creek, Second Creek and Bylew.

13. *Eurycea longicauda* (Green), long-tailed salamander. Common around springs and damp entrances to caves. It has been observed many times far back in caves which contain streams of running water.

14. *Eurycea lucifuga* Rafinesque, cave salamander. Common around springs, and especially in damp caves, where it may be found on the walls, floors, or near streams far from the light. The specimens found the greatest distance from the surface show no color change.

15. *Desmognathus fuscus fuscus* (Rafinesque). Not common, but found near the base of wooded slopes about small springs.

*16. *Desmognathus phoca* (Matthes). Common around springs and rocky streams. This species has been confused with *D. f. fuscus* in this area.

* 17. *Scaphiopus holbrookii holbrookii* (Harlan), spadefoot. Abundant, but found only during breeding season in ponds, both on the ridges and in the valleys. It was first heard on the evening of June 17, 1935, about 8 p. m., following a heavy rain which started about 7 p. m. and lasted about 20 minutes. Hundreds of spadefoots were calling, and many were observed laying eggs in the bottom of the shallow pools left standing from the rain, as well as in the more permanent ponds. All the males observed were calling from the water or from the edge of the pool. On June 21 it showered most of the day, and spadefoots were calling at noon. I visited a pool at 3 p. m., during a heavy shower. Many were heard but they could not be observed, since they were calling from the bottom of the pool. Their chorus was continuous until disturbed. Two males were observed to come out of the woodland opposite the pool and cross the highway to join their companions. The next morning the bottom of the pool was covered with eggs.

18. *Bufo americanus americanus* (Holbrook), American toad. This common form is silent during the summer months and seems to be secretive in habit. March 20, 1935, over 150 individuals were observed mating and in full chorus in a pond in Doyle Valley, and in several other pools as well. These toads were heard in chorus throughout the park during the last two weeks of March.

19. *Bufo woodhousii fowleri* (Hinckley), Fowler's toad. Abundant. Chorus and egg-laying on the night of April 19, 1935. Calls may be heard throughout late spring, summer and early fall.

20. *Acris gryllus* (Le Conte), cricket frog. Abundant. Heard calling March 5, 1935. A few were laying eggs on April 19, but they did not reach full chorus until June 4, 1935.

* 21. *Pseudacris brachyphona* (Cope), chorus frog. Common, especially around small streams and springs. They were first heard March 4, 1935.

March 19 they were in full chorus and mating. The last were heard on the night of June 4, 1935.

* 22. *Hyla crucifer* Wied, spring peeper. Abundant. The first were heard on the night of March 5, 1935. They were in full chorus and mating on the night of March 19. On this date a large bullfrog, *Rana catesbeiana*, was taken which had swallowed 22 spring peppers. *Rana clamitans* was also observed feeding upon this little tree frog.

23. *Hyla versicolor versicolor* (Le Conte), tree toad. Abundant. May be heard during the day and night, from late spring to early fall. Found in full chorus and mating on the night of June 4, 1935.

24. *Rana catesbeiana* Shaw, bull frog. Abundant around large ponds and streams. Commonly confused in this area with *Rana clamitans*. Both are hunted constantly for frog legs.

25. *Rana clamitans* Latreille, green frog. Abundant along streams, springs and ponds. This species, which is used for food in this area, is commonly confused with the bullfrog.

26. *Rana palustris* Le Conte, pickerel frog. This frog is common in the damp entrances of caves.

27. *Rana pipiens* Schreber, leopard frog. Abundant around small ponds and marshy areas, also small streams.

* 28. *Rana sylvatica* Le Conte, wood frog. Rare, only one specimen found in a dense growth of ferns under hemlock and magnolia trees, in a deep shaded canyon at the head of Wet Prong Buffalo creek.

* 29. *Microhyla carolinensis* (Holbrook), narrow-mouthed frog. Common. It was observed in full chorus on the afternoon of May 23, 1935. Many eggs were layed that night.

30. *Sceloporus undulatus* (Latreille), fence lizard. Abundant on wooded ridges and slopes.

31. *Ophisaurus ventralis* (Linnaeus), legless lizard. Common on ridges and in old fields.

32. *Cnemidophorus sexlineatus* (Linnaeus), six-lined lizard. Abundant along paths and in old fields where there are clearings.

* 33. *Leiolopisma unicolor* (Harlan), ground lizard. Rare in park area. Only one specimen has been observed in 15 months of work.

* 34. *Eumeces anthracinus* (Baird), the black skink. Rare; only one specimen has been observed, which was taken on the wooded Mammoth Cave ridge, in a small pond, on a log within a few inches of the bank. The specimen took freely to the water before being captured.

35. *Eumeces fasciatus* (Linnaeus), blue-tailed skink. Common throughout the wooded areas.

* 36. *Eumeces laticeps* Schneider. Abundant.

37. *Carphophis amoena helenae* (Kennicott), worm snake. Common, many specimens with the internasals and prefrontals separated.

38. *Diadophis punctatus edwardsii* (Merrem), ring-necked snake. Common on wooded slopes and ridges under stones and logs.

39. *Heterodon contortrix* (Linnaeus), spreading adder. Common, including melanistic forms.

40. *Opheodrys aestivus* (Linnaeus), rough, green snake. Common in wooded areas, including second-growth forests.

41. *Coluber constrictor constrictor* (Linnaeus), black snake. Abundant, especially in wooded regions.

*42. *Elaphe guttata* (Linnaeus), corn snake. Rare, only three specimens.

43. *Elaphe obsoleta confinis* (Baird and Girard), gray pilot. Abundant. No forms that I have examined resemble *E. o. obsoleta*.

*44. *Pituophis melanoleucus* (Daudin), pine snake. Rare, only four have been observed, and these were on the north side of Green river, near Ollie, Kentucky.

*45. *Lampropeltis calligaster* (Harlan), gray king snake. Rare; five have been observed in the park area.

*46. *Lampropeltis elapsoides elapsoides* (Holbrook), coral king snake. Rare; only one was found (north side of Green river).

47. *Lampropeltis getulus nigra* (Yarrow), black king snake. Common. A number found in nests of red-tailed hawks, where they were used as food.

48. *Lampropeltis triangulum triangulum* (Lacepede), milk snake. Rare; two have been observed.

*49. *Cemophora coccinea* (Blumenbach), scarlet snake. Rare; only one observed. This was taken from under a stone during road construction.

50. *Natrix sipedon sipedon* (Linnaeus), water snake. Common along river, streams, and around ponds.

51. *Storeria dekayi* (Holbrook), Dekay's snake. Rare; only one has been observed, which was taken in Katy Pace valley, in an old broom sedge field.

52. *Storeria occipito-maculata* (Storer), red-bellied snake. Common under logs and stones in wooded areas.

53. *Thamnophis sirtalis sirtalis* (Linnaeus), common garter snake. Common.

*54. *Tantilla coronata* Baird and Girard, tantilla. Common, especially along southern rocky wooded slopes.

55. *Agkistrodon mokasen* Beauvois, copper head. Abundant, especially in damp woods.

56. *Crotalus horridus* Linnaeus, timber rattlesnake. Common on wooded ridges and slopes. Two specimens have been observed, which measured 55 and 57 inches, respectively. One contained an adult gray squirrel and the other two gray squirrels two thirds grown.

*57. *Kinosternon subrubrum subrubrum* (Lacepede), musk turtle. Common near ponds.

58. *Chelydra serpentina* (Linnaeus), common snapper. Common near ponds, streams and rivers.

59. *Terrapene carolina* (Linnaeus), box terrapene. Abundant. They are often found in small pools of water during the hot season.

60. *Graptemys geographica* (Le Sueur), map turtle. Abundant along Green river.

61. *Pseudemys concinna* (Le Conte), striped turtle. Common along Green river.

62. *Pseudemys elegans* (Wied), Cumberland turtle. Abundant along Green river.

*63. *Amyda spinifera* (Le Sueur), leather-backed turtle. Common in Green river.

Notes on Faunal Collecting in Kansas

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While a student at Southwestern College, Winfield, Kan., the writer accompanied Dr. Charles E. Burt[1] on extensive faunal-collecting trips throughout Kansas and surrounding states. Many species of animals were collected in large numbers from 74 counties of the state. A wide range of habitats was encountered and many observations were made in regard to habits and life histories. The specimens have been used for student dissection, for museum display mounts, research, or sent to museums and zoölogical parks.

PROTOZOA AND ROTIFERA

About ten different species of Protozoa and Rotifera were collected and were used for laboratory study in general zoölogy. They were taken from the surface of the water as pond scum. *Euglena viridis* appeared in large numbers when first removed from a pond near Winfield, Kan., but upon standing for a few days the *Euglena viridis* disappeared and *Paramecium caudatum* became dominant as is commonly the case in vivaria. Many other species of protozoa appeared in the media but were unidentified.

PLATYHELMINTHES AND NEMATHELMINTHES

Of the platyhelminthes, special emphasis was placed on cestodes taken from dogs which were obtained from the city dog pound through the courtesy of the city dog catcher of Winfield. It has been observed that during the late spring and summer the tapeworms are relatively scarce, short, and very fragile, while during the late fall, winter, and early spring the worms are numerous, long, and pliable. It is the writer's opinion that the dogs are able to at least partially worm themselves in the spring and summer by eating grass, as grass was found in the intestines of many dogs. In the intestines of the dogs that had eaten grass, the nongravid proglottids were often unattached, and appeared as though they were cut by the sharp, rough edges of the grass blades. The dogs that had showed no indication of having eaten grass presented no evidence of the preceding condition, and the nongravid proglottids were all attached. It is thought that the grass may be a mechanical irritant to the tapeworm, as the scoleces were also removed from the mucous membranes of the intestine. The two principal species of tapeworms taken from the dogs were *Dipylidium caninum* and *Taenia pisciformis* (= *Taenia serrata*.) Two hundred and twenty-five *Taenia pisciformis* was the maximum number of worms taken from one dog, which was a small fox terrier. The alimentary canal was so matted with these worms that the intestine was greatly distended. One specimen of special interest had two scoleces attached to one chain of proglottids. Tapeworms were found less frequently in house dogs

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1. Professor of Biology, Southwestern College, Winfield, Kan., to whom I am greatly indebted for giving me the opportunity to study and collect with him. Through this courtesy I was able to gain much of the information for this paper. Further acknowledgments are due the following professors of Kansas State College, Manhattan, Kan., for suggestions offered in preparation of this paper: Profs. H. R. Bryson, R. C. Smith, R. H. Painter, J. E. Ackert, M. J. Harbaugh, and A. L. Goodrich.

than in the common cur or stray. *Dipylidium caninum* are found more frequently in the fall and early winter, while *Taenia pisciformis* are found to be most plentiful during the early spring months.

Unidentified nematodes were taken in large numbers from the intestines of pigs, and in smaller numbers from dogs and cats.

MOLLUSCA

Snails and clams were collected in October, 1932, from the bed of Caney river, Camp Ta-la-hi, Cedervale, Chautauqua county, Kansas. About 100 specimens of clams, including representatives of ten different species, were identified and deposited in the U. S. National Museum. These were *Lampsilis cardium* Raf., *Lampsilis teres* Raf., *Lampsilis fragilis* Raf., *Lampsilis purpurata* Lam., *Ptychobranchus fasciolare* Raff., *Symphynota complanta* Bar., *Amblema costata* Raf., *Quadrula quadrula* Raf., *Quadrula coccinea* Conrad, and *Quadrula* (*Tritogonia*) *verrucosa* Raf.

ARTHROPODA

Extensive collections were made of insects, crustaceans, centipedes, scorpions, and spiders. Centipedes were found especially throughout the limestone areas of Kansas. Centipede collecting is largely seasonal, but best at the mating season, from the first to the middle of April in Kansas. During this time centipedes are very abundant, and if weather conditions are right they may be found under nearly every flat rock in some localities. They are easier to collect during early morning or late evening, which appears to be their feeding time. Centipede collecting is very good after a warm rain when the sun comes out warm. The common centipedes of Kansas are the large brown species (*Scolopendra heros*), the large black centipede (*Scolopendra gigantea*), and the small brown centipede (*Lithobius forficatus*).

Scorpions (*Centruroides vittatus*) have been found in early spring in large numbers under large flat rocks near gooseberry, currant, plum, or sumac thickets, just after they came from hibernation. Specimens have been found by the writer in a large mass or ball of individuals in hibernation in early February.

The hour-glass spider (*Lactrodectes mactans*), or black widow, as it is commonly called, has been taken in many counties of this state. They are frequently found under rocks, rotted logs, tin cans and other debris, as well as in basements, barns, and outhouses. A sporadic outbreak occurred in 1934, in which several hundred specimens were collected by the writer in Cowley county, Kansas, but during the past year they appeared to be less numerous.

Over one thousand June beetles (*Phyllophaga* spp.) were taken in less than an hour near Matfield Green, Chase county, Kansas, on April 10, 1934. They were observed when they flew in great numbers into the headlights of a moving car. The beetles were collected from the ground, stunned after flying against the car. The beetles were coming from a wooded ravine. This large-scale emergence took place just preceding a heavy rain.

More than 2,500 dog fleas (*Ctenocephaloides canis*) were taken from a small dog at Winfield during the months of July and August, 1935. The fleas were removed at intervals of two or three days by means of small forceps. The dog at first resisted the flea-removing process, but soon became accustomed to it and learned to lie quietly.

In early December, 1935, the writer collected 1,500 fleas from the dirt-floored basement of a home in Manhattan, Kan., in about two hours. Dogs had been housed in the basement. As the population of fleas increased, they came up into the house through the hot-air register and annoyed the family to such an extent that the members were almost forced from their home. The fleas appeared in such large numbers as to make a brown-spotted appearance on the basement floor. The collector secured the fleas one at a time by means of small forceps, and placed them in alcohol.

PISCES

Only small numbers and few species of fish were taken. A number of long-nosed gar pike (*Lepisosteus osseus*) were taken from the Walnut river at Winfield, Kan., in 1934-'35, and from the Arkansas river west of Winfield, Kan., in 1934. On the evening of August 12, 1934, thirty-two of the gar pikes were seined from a hole of water ten feet deep in the Arkansas river. The water in the river was low and the gar pikes had congregated in an old sand pit. They ranged in length from 24 to 43 inches. Repeating the process two weeks later yielded similar results, with a catch of 28. On the Walnut river, large numbers of various sizes of gar pikes were taken from a whirlpool which was about twenty feet across, fifty feet long, and ten feet deep.

AMPHIBIANS

During the first week of September, 1934, the writer collected over 500 frogs in five evenings, working with flashlight only two or three hours each evening. The frogs (*Rana catesbeiana* and *Rana pipiens*) were congregated along the edges of sparse, shallow pools. Due to the drought, the stream was drying and the frogs congregated at these pools just before going into hibernation. The collection was sent alive to the U. S. National Zoölogical Park at Washington, D. C., to be used as reptile and bird food during the following winter.

Insects were collected with dip nets and sweeping nets; gar pikes and turtles were taken by seine, while frogs, lizards and snakes were captured by flashlight, by hand or by means of large collecting forceps. The following preservatives were used: 70 percent alcohol; also, 90 percent or 95 percent alcohol plus 10 percent glycerine, 4 percent formalin and Gilson's solution.

The data in the table which follows are the results of four years' faunal collecting in Kansas, but include only specimens taken in unusually large numbers. The date in the table indicates the season in which specimens were collected with the greatest ease.

Kind of Animal Collected in Large Numbers.	Kansas locality collected in greatest abundance.	Habitat.	Date or season collected in greatest abundance.
1. Euglena (*Euglena viridis*)*	Winfield, Cowley county.	Pool covered with algae and pond scum.	September 20, 1934.
2. Paramecia* (*Paramecium caudatum*).	Winfield, Cowley county.	Pool covered with algae and pond scum.	September 20, 1934.
3. Dog tapeworms* (*Dipylidium caninum*). (*Taenia pisciformis*).	Winfield, Cowley county.	Duodenum of dog intestine; also entire small intestines, usually not in large intestine.	Late fall and early winter (*Dipylidium caninum*). Late winter and early spring (*Taenia pisciformis*).
4. Clams* (*Lampsilis cardium*). (*Lampsilis teres*). (*Lampsilis fragilis*). (*Lampsilis purpurata*). (*Ptychobranchus fasciolare*). (*Symphyonata complanta*). (*Amblema costata*). (*Quadrula quadrula*). (*Quadrula coccinea*). (*Quadrula* (*Tritogonia*). *verrucosa*).	Cedarvale, Chautauqua county.	Caney river bed, mud bottom, 2½ feet deep, near riffle.	Mid-October, 1932.
5. Centipede* (*Lithobius forficatus*.)	Cowley and Riley counties.	Under small, flat rocks, moist situation.	April, May, 1932-1935.
6. Centipede* (*Scolopendra heros*).	Cowley and Riley counties; Elk and Wabaunsee counties.	Under small, flat rocks, not embedded, moist situation.	April 1 to 20, 1932-1935.
7. Centipede* (*Scolopendra gigantea*).	Cowley and Elk counties.	Under large embedded rocks, moist situation.	June to July, 1932-1935.
8. Scorpion* (*Centruroides vittatus*).	Cowley county.	Under flat rocks in dense plum or sumac thickets.	April, 1935.

* Indicates specimens referred to in paper.

Kind of Animal Collected in Large Numbers.	Kansas locality collected in greatest abundance.	Habitat.	Date or season collected in greatest abundance.
9. Crayfish (*Cambarus* spp.)	Cowley county.	Dutch Creek, below dam, flat rock bottom, mud banks.	July, 1934.
10. Hour glass spider* (*Lactrodectus mactans*).	Cowley and Elk counties.	Under flat rocks, logs, and in buildings, seek musty habitat.	April, May, 1934.
11. Spinose ear tick (*Ornithodorus megini*).	Slaughter House, Wichita, Sedgwick county.	Parasitic, deep in ears of Texas cattle.	December 24, 1935.
12. Red mites, chiggers (*Trombicula* spp.).	Cowley county.	Under rocks, on weeds and bark of trees.	April, May, October, 1932-1935.
13. Spring tails (Collembola).	Manhattan, Riley county.	Under rocks, bark of trees and in mullen foliage.	March, 1936. August, Sept., 1934.
14. Grasshoppers (Acrididae).	Elk, Cowley and Riley counties.	In corn fields, on sunflowers and in meadows.	Summers, 1934-1936.
15. Cricket (*Gryllus assimilis*).	Elk and Cowley counties.	Under rocks, logs and under wheat shocks.	July, August ,September, 1932-1935
16. Cockroaches (*Periplaneta americana*) (*Blattella germanica*) (*Blatta orientalis*).	Manhattan, Riley county. Winfield, Cowley county.	In feed barrels, under boards, straw and paper.	March 18, 1936.
17. Termites (*Reticulitermes* spp.).	Manhattan, Riley county.	Along cement curb in cemetery, under wood, bark, and a colony was found emerging from crack of sidewalk.	March 7, 17, 18, 1936.
18. Lacewings (*Chrysopa* spp.)	Cheney, Sedgwick county. Cowley and Riley counties.	Sitting on weeds along a small wooded stream.	May 20, 1934.

Kind of Animal Collected in Large Numbers.	Kansas locality collected in greatest abundance.	Habitat.	Date or season collected in greatest abundance.
20. Mayflies (*larvae*) (Ephemerida).	Riley county.	Under rocks in shallow water, near riffles.	April, 1935.
21. Damsel flies (Zygoptera).	Cowley county.	On rocks near water's edge, near riffles.	August, 1935.
22. Mullen thrips (*Neoheegeria verbasci*).	Manhattan, Riley county.	In foliage of mullen plants.	March, 1936.
23. Cicadas, leafhoppers (Homoptera).	Winfield, Cowley county. Manhattan, Riley county.	Sitting on limbs and leaves of scrub bushes of sumac and oak.	August, September, October, 1935.
24. Chinch bug (*Blissus leucopterus*).	Grenola, Elk county.	In the leaf sheaths of kafir corn.	August 28, 1935.
25. Squash bug (adults, nymphs) (*Anasa tristis*).	Manhattan, Riley county.	On squashes and at the roots of squash vines.	October, November, 1935.
26. Back-swimmers (Notonectidae).	Manhattan, Riley county.	In shallow water of muddy pond.	March 15, 1936.
27. Water-boatman (Corixidae).	Manhattan, Riley county.	In shallow water of muddy pond.	March 15, 1936.
28. Stink bugs (Pentatomidae).	Manhattan, Riley county.	On weeds and grasses on hillsides.	October, 1935.
29. Tarnished plant bugs (Miridae).	Manhattan, Riley county.	On weeds and grasses on hillsides.	October, 1935.
30. Rove beetles (Staphylinidae).	Manhattan, Riley county.	In body cavity of decaying cat.	October, 1935.

KIND OF ANIMAL COLLECTED IN LARGE NUMBERS.	Kansas locality collected in greatest abundance.	Habitat.	Date or season collected in greatest abundance.
31. June beetles* (*Phyllophaga* sp.)	Matfield Green, Chase county.	Wooded ravine.	April 10, 1934.
32. Darkling beetles (TENEBRIONIDAE)	Winfield, Cowley county. Manhattan, Riley county.	Under flat rocks, moist situation.	May, June, October, 1932-1935.
33. Ground beetles (*Harpalus* spp.).	Winfield, Cowley county.	Under wheat shocks, under rocks.	July, 1935.
34. Potato beetle (*Leptinotarsa decemlineata*).	Winfield, Cowley county.	On potato and "bull nettle" foliage.	May, June, 1932-1935.
35. Corn root worm beetle (*Diabrotica duodecimpunctata*).	Winfield, Cowley county. Manhattan, Riley county.	On squash vines and on ground near roots; also, feeding on squashes.	October, November, 1935.
36. Striped cucumber beetle (*Diabrotica vittata*).	Manhattan, Riley county.	On squash vines and on ground near roots; also, feeding on squashes.	October, November, 1935.
37. Ladybird beetles (COCCINELLIDAE).	Winfield, Cowley county. Manhattan, Riley county.	Feeding on squashes; also, on blossoms of trumpet vine.	August, 1935.
38. Blister beetles (MELOIDAE).	Grenola, Elk county.	On weeds and alfalfa.	August, 1934.
39. Snout beetles (RHYNCHOPHORA).	Manhattan, Riley county.	Under alfalfa hay.	October, 1935.
40. Cabbage butterfly (*Ascia rapae*).	Winfield, Cowley county.	Near alfalfa field, on lawns, and in gardens.	May, June, 1935.
41. House fly (adults, puparia, larvae) (*Musca domestica*).	Cowley and Riley counties.	Poultry slaughter barrel and dairy barns.	August, September, 1935.

Kind of Animal Collected in Large Numbers.	Kansas locality collected in greatest abundance.	Habitat.	Date or season collected in greatest abundance.
42. Robber flies (*Erax spp.*).	Winfield, Cowley county.	On rocks in pasture, feeding on insects.	August, 1935.
43. Mosquitoes (Culicidae).	Winfield, Cowley county.	In rain barrel.	July, 1935.
44. Crane flies (Tipulidae).	Winfield, Cowley county.	In tall grass, also, flying from dry leaves.	May, November, 1935.
45. Dog flea* (*Ctenocephaloides canis*).	Winfield, Cowley county. Manhattan, Riley county.	On dogs and in basement of a house.	July, August, December, 1935.
46. Garpike fish* (*Lepisosteus osseus*).	Winfield, Cowley county.	Walnut river in whirlpool, 19 feet water—Arkansas river, sand pit, 10 feet water.	August, September, 1934-1935.
47. Cricket frog (*Acris gryllus*).	Winfield, Cowley county.	Sitting along gravel bank of streams, usually near riffles.	July, August, 1932-1935.
48. Bull frog* (*Rana catesbeiana*).	Winfield, Cowley county.	Congregated along banks of shallow pools.	September, 1934.
49. Leopard frog* (*Rana pipiens*).	Winfield, Cowley county. Lake City, Barber county.	Along roadside ditch, matted with grass; also, on bank above water.	April, 1935.
50. Woodhouse's toad (*Bufo woodhousii*).	Lake City, Barber county.	Along shallow, temporary, sandy pools.	April, 1935.
51. Ornate box turtles (*Terrapene ornata*).	Winfield, Cowley county.	Aestivating under rocks; also, in mud along streams.	August, 1935.
52. Snapping turtle (*Chelydra serpentina*).	Winfield, Cowley county.	In whirlpool of Walnut river; also, in mud-bottomed stream, Timber creek.	August, 1935.

Kind of Animal Collected in Large Numbers.	Kansas locality collected in greatest abundance.	Habitat.	Date or season collected in greatest abundance.
53. Musk turtle (*Kinosternon flavescens*).	Hudson, Stafford county.	Roadside ditches filled with water, near Salt Marsh.	May, 1934.
54. Six-lined race-runner (*Cnemidophorus sexlineatus sexlineatus*).	Winfield, Cowley county. Wabaunsee, Ellsworth and Stafford counties.	Under rocks in early spring, in grasses and bushes during the summer.	April, May, 1932-1935.
55. Prairie-swift lizard (*Sceloporus undulatus consobrinus*).	Stafford and Cowley counties.	Sand hills—yucca in peach and apple orchards.	May, July, August, September, 1932-1934.
56. Spotted earless lizard (*Holbrookia maculata maculata*).	Stafford county.	Sand hills, under bushes and in grass along roadside.	May, 1934.
57. Grey skinks or Sonoran skink (*Eumeces obsoleta*).	Cowley county. Carneiro, Ellsworth county.	Under rocks somewhat embedded, rather moist situation.	April, May, June, 1932-1935.
58. Five-line skink (*Eumeces fasciatus*).	Mortimer, Labette county.	Under rocks above streams, moist habitat.	April 22, 1933.
59. Northern skink (*Eumeces septentrionalis*).	Cottonwood Falls, Chase county.	Under large rocks in prairie, above ravine.	May 12, 1933.
60. Horned lizard (*Phrynosoma cornutum*).	Cedarvale, Chautauqua county.	Among wheat stubbles and rocky hillsides.	June, July, August, 1932-1935.
61. Collared lizard (*Crotaphytus collaris*).	Winfield, Cowley county.	Under rocks in spring; during summer are found sitting on large boulders.	April, May, June, 1932-1935.
62. Ring neck snake (*Diadophis punctatus aryni*).	Winfield, Cowley county. Chase county.	Under rocks and logs where much moisture is available, usually along wooded hillsides.	April, May, 1932-1935.

Kind of Animal Collected in Large Numbers.	Kansas locality collected in greatest abundance.	Habitat.	Date or season collected in greatest abundance.
63. Sand snake (*Tantilla gracilis gracilis*).	Winfield, Cowley county.	Under shaled rock ledges, near streams.	April, May, 1932-1935.
64. Red sided garter snake (*Thamnophis sirtalis parietalis*).	Winfield, Cowley county.	Along banks of small streamlets where small frogs, tadpoles, crustaceans and water insects are available for food.	May, 1933-1935.
65. Ribbon snake (*Thamnophis lineatus*).	Winfield, Cowley county.	Under small rocks along grassy hillsides, also, along wooded ravines.	April, May, 1934-1935.
66. King snake (*Lampropeltis calligaster*).	Winfield, Cowley county.	Under rather large rocks in open prairie areas.	May, June, 1933-1935.
67. Salt and pepper snake (*Lampropeltis getulus holbrooki*)	Winfield, Cowley county.	Under rocks usually near timberland; but also, in open prairies.	May, June, 1933-1935.
68. Bull snake (*Pituophis sayi sayi*).	Winfield, Cowley county.	Under rocks near wooded streams; also, stay near farm dwellings.	May, June, 1933-1935.
69. Water snake (*Natrix sipedon sipedon*). (*Natrix sipedon transversa*).	Winfield, Cowley county. Mayfield, Sumner county.	Under rocks along riffles of small streams, or about drifts or debris in streams.	May, June, 1933-1935.
70. Black or chicken snake (*Elaphe obsoleta*).	Winfield, Cowley county. Grenola, Elk county.	Under rocks in wooded areas near streams, or in granaries.	July, 1933.
71. Rat snake (*Elaphe laeta*).	Winfield, Cowley county.	Along rocky hillsides, usually near streams.	May, June, 1932-1935.
72. Whip-snake (*Masticophis flagellum flagellum*)	Cedarvale, Chautauqua county. Cowley county.	Under rocks along rocky hillsides.	April, May, 1932-1935.

KIND OF ANIMAL COLLECTED IN LARGE NUMBERS.	Kansas locality collected in greatest abundance.	Habitat.	Date or season collected in greatest abundance.
73. Sonoran snake................. (*Sonora semiannulata*).	Winfield, Cowley county.	Under shaled rocks, moist situation.	April, May, 1932-1935.
74. Copperhead snake.............. (*Agkistrodon mokasen*).	Cedarvale, Chautauqua county.	In rocky, timbered areas; frequently found under or about oak leaves; crawling about dusk.	August, 1932.
75. Pigmy prairie rattlesnake........ (*Sistrurus catenatus catenatus*).	Winfield, Cowley county.	Lying among rocks, or under flat rocks on grassy hillsides.	September, 1934-1935.

An Annotated List of the Birds of Rooks County, Kansas, and Vicinity

RALPH H. IMLER, Stockton, Kan.

The following annotated list of birds is the result of ten years of study and observation in Rooks, Ellis, and Graham counties. For comparison with the records in these counties, studies were also made in Geary, Logan, and Scott counties. The most extensive work was done in Rooks county in 1935 and 1936, in the vicinity of Stockton. Much time was spent in observing and collecting along the south fork of the Solomon river, which runs within a few hundred yards of Stockton on the southwest. Many field trips were taken into the upland prairies.

The Solomon river flows east through Rooks county. Its course is marked through most of this county by a winding strip of timber. The principal trees are cottonwood and white elm. The bottomland of this stream averages about one half mile in width. It is largely in cultivation. There are scattered strips, some of them over one fourth mile in width, that are too sandy to farm. Some of this sandy area consists of dunes, where the vegetation is scant and is made up principally of plum brush and prickly pears, with a few scattered hackberry and ash trees.

The bluffs bordering the stream rise abruptly on the south to a maximum height of 160 feet above the river. On the north they are of about the same average height, but are not so steep. These bluffs are underlaid with limestone, which crops out along the rims. They are too rocky and rough to cultivate and are nearly all in little bluestem (*Andropogon scoparius*), which is used for grazing. Above the rims and on the upland prairies buffalo grass (*Buchloe dactyloides*) is the principal cover where the land is not in cultivation. The bluffs are cut by ravines in which scrubby white elm, ash, and hackberry trees are found (fig. 1). Golden eagles roost in these trees in the winter, while bald eagles are common locally, in the taller trees along the river (fig. 2).

Most of the land back of the bluffs is in cultivation and is quite level. There are few trees here excepting those planted around the farm sites and occasional timber claims (fig. 3). The principal crops are wheat, corn, kafir, and cane.

The dry summer of 1933 and the unprecedented drought of 1934 affected some of the species considerably. Most noticeable was the absence of dickcissels in 1934. Although the late summer of 1935 was dry, the spring was wet. The Solomon river was at flood stage June 1 and 16, 1935. Many farmers were unable to get into their fields for planting until late in June. This unusually wet weather may account for the observation of several species of Passeriformes in 1935 that I had not observed in the county before.

The Solomon river went dry, except in the deeper holes, in the summers of 1933 and 1934. In the memory of the oldest settlers there has been only five or six times before 1933 when this river has been dry. It was never dry during 1935, although it was very low in August.

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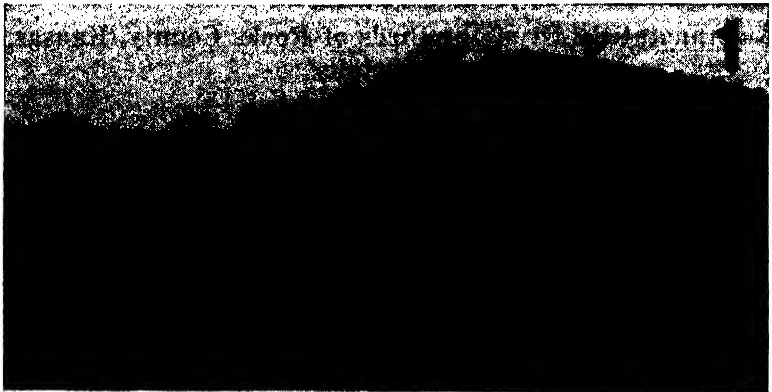

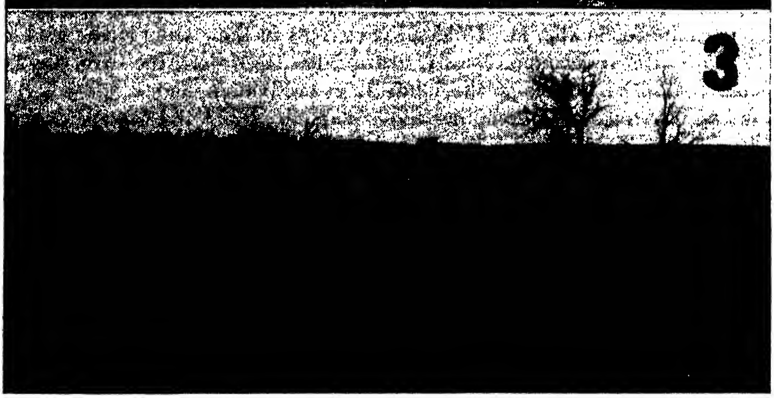

FIG. 1 (Upper). Rocky bluff covered with scrubby white elm and ash trees in which three golden eagles roosted from November, 1935, to April, 1936.

FIG. 2 (Middle). Cottonwood trees on the bank of the Solomon river. Twenty-three bald eagles were counted and many pellets collected here.

FIG. 3 (Lower). A typical old-timber claim of the uplands near Stockton, Kan.

Because there are no large bodies of water in this area, the number of water- and marsh-inhabiting species in the list is meager. This also accounts for the fact that some birds are listed as migratory which may nest in other parts of the state. This lack of opportunity to observe water birds was partly overcome by examining birds killed by the sportsmen of Stockton. Nearly 100 ducks of 9 species were obtained in this way for study in the fall of 1935. Weights and measurements were recorded for each bird.

Much information has been obtained through banding operations. With the aid of my students, especially Kenneth Kennedy, Charles Fleming, Robert Snyder, and Kenton Snyder, I have been able to band and study in hand 62 birds of prey of 14 species during the winter of 1935 and 1936.

In comparing notes with those of Colonel Goss in "Birds of Kansas," published in 1891, I have found that the abundance of some species has changed considerably. This is most noticeable in the water birds.. In his book, which is the most extensive work covering this region, he has often given the abundance only in the state as a whole. Due to the fact that western Kansas is so entirely different from eastern Kansas, much local work is needed. Of the work that has been done in the state, very little has been in the western part. Subspecific determination of skins is especially important in this region because it is so often on a dividing line. The one hundredth meridian, often mentioned in the ranges of species and subspecies, is 40 miles west of Stockton.

All notes are for Rooks county unless some other locality is specified. Excepting where credit is given to others, I obtained all records and collections personally. Each species and subspecies was either collected and determined or positively identified in the field. Doubtful records have been omitted. All skins mentioned in this paper are now in my possession unless other locations are given.

Much credit is due those who helped in this work. Dr. L. D. Wooster, of Fort Hays Kansas State College, Hays, Kan., suggested the writing of this paper, checked the manuscript, and obtained several of the records. Dr. J. M. Linsdale, of the University of California, read the manuscript and gave some helpful criticisms. Dr. Alexander Wetmore, of the Smithsonian Institution, Washington, D. C., and Dr. Harry C. Overholser, senior biologist of the United States Biological Survey, determined the subspecies of many skins.

Family Colymbidae. Grebes.

Colymbus nigricollis californicus. Eared Grebe.

Rare. One specimen collected in Graham county in the fall of 1929 is now in the possession of Charley Buss, of Bogue, Kan.

Podilymbus podiceps podiceps. Pied-billed Grebe.

Common in migration. In the spring of 1935 the first record was April 20.

Family Pelecanidae. Pelican.

Pelecanus erythrorhynchos. White Pelican.

Occasional migrant. A specimen carrying Biological Survey band number A725268 was found with both legs broken, caught in a wire fence during a dust storm in April, 1935. Doctor Wooster reports they are occasionally seen on the Smoky Hill river south of Hays. A male in the writer's collection was shot from a flock of six in Graham county in the spring of 1929.

Family ANHINGIDAE. Darters.

Anhinga anhinga. Water Turkey.

One of these birds was shot in 1933 on Cheyenne bottoms, which is about one hundred miles southeast of Stockton. The specimen was mounted and is now in Hoisington, Kan.

Family ARDEIDAE. Herons.

Ardea herodias herodias. Great Blue Heron.

Common in migration.

Butorides virescens virescens. Eastern Green Heron.

Common during migration. Rare in summer. Arrives in May.

Nycticorax nycticorax hoactli. Black-crowned Night Heron.

Common in spring and fall. Arrives in May. A male in writer's collection was shot May. 20, 1935. A female was shot near Stockton, October 20, 1935.

Botaurus lentiginosus. American Bittern.

Fairly common in migration. One nest was found in Graham county in 1929. Two skins in writer's collection.

Family ANATIDAE. Ducks, Geese.

Branta canadensis canadensis. Canada Goose.

Fairly common migrant. About twenty were seen feeding in a field April 6, 1936.

Chen hyperboreas hyperboreas. Lesser Snow Goose.

One was shot near Stockton in the spring of 1933.

Anas platyrhynchos platyrhynchos. Common Mallard.

Common migrant. This is the most common duck here. It was abundant November 2 to 4, 1935. On January 13, 1935, a flock of eight mallards was seen with six canvasbacks on the Solomon river. Over 250 were counted on the Scott County State Lake, November. 29, 1935.

Chaulelasmus streperus. Gadwall.

Fairly common migrant. Often with mallards. In the fall of 1935 gadwalls were first seen on October 22, and last seen on November 5.

Mareca americana. Baldpate.

Not uncommon migrant. In 1935 two were taken by hunters on October 31, and another November 12. The last was with a hooded merganser on the Solomon river.

Dafila acuta tzitzhoa. American Pintail.

Occasional migrant. A flock of about 45 was seen February 13, 1934. A male was seen with mallards on the Scott County State Lake November 29, 1935.

Nettion carolinense. Green-winged Teal.

Common in migration. Very common November 2 to 4, 1935. Exceeded in abundance only by mallards and lesser scaups in the fall flight of 1935.

Querquedula discors. Blue-winged Teal.

Fairly common in migration. Occasional in summer in favorable localities. Three were seen continually for about a week on a small pond in Trego county in early July, 1926.

Querquedula cyanoptera. Cinnamon Teal.
Two records in fall migration.

Spatula clypeata. Shoveller. Spoonbill.
Fairly common migrant. Earliest fall record in 1935 was October 21. Five were seen March 21, 1935; two March 21, 1936.

Nyroca americana. Redhead.
Fairly common migrant. Several were observed November 3, 1936.

Nyroca valisineria. Canvasback.
Uncommon migrant. Six canvasbacks were seen with eight mallards on the Solomon river January 13, 1935.

Nyroca marila. American Scaup Duck.
Rare migrant. Three were shot November 3, 1935.

Nyroca affinis. Lesser Scaup Duck.
Common migrant. Most common duck here excepting mallards. Abundant November 2 to 4, 1935. Lone male observed March 26, 1933.

Charitonetta albeola. Bufflehead.
Rare migrant. Seen twice in fall migration.

Erismatura jamaicensis rubida. Ruddy Duck.
Fairly common migrant. Usually solitary. A male seen March 21, 1935.

Lophodytes cucullatus. Hooded Merganser.
Rare. A female shot November 4, 1935.

Mergus merganser americanus. American Merganser.
Fairly common in migration. Occasionally seen in winter wherever there is open water. A female was shot near Stockton November 12, 1935. It was with a baldpate female. About two hours after being crippled the merganser ejected 19 small minnows which averaged about two inches in length. Twenty-nine mergansers were counted on the Scott County State Lake, November 29, 1935.

Family CATHARTIDAE. Vultures.

Cathartes aura septentrionalis. Turkey Vulture.
Fairly common summer resident. Occasional during most of the winter. Usually nests in rocky cliffs.

Family ACCIPITRIIDAE. Hawks.

Accipiter velox. Sharp-shinned Hawk.
Rather rare except in migration.

Accipiter cooperi. Cooper's Hawk.
Fairly common resident. Several birds of this species have been brought to Stockton High School Science Department and most of them were caught in the act of striking chickens. One female skin in writer's collection.

Buteo borealis borealis. Eastern Red-tailed Hawk.
Fairly common resident. Common in September, 1935, during which month three were banded. One adult and one immature of this subspecies is in the writer's collection.

Buteo swainsoni. Swainson's Hawk.
Common summer resident. First seen in 1933 on April 28. Latest fall record October 15, 1935. A migration flock of approximately 200 was

seen September 29, 1935. Two birds shot by hunters from this flock were examined, and each stomach contained over 50 grams of grasshoppers.

Buteo lagopus s. johannis. American Rough-legged Hawk.
Very common winter resident. From late October to March this is the most common hawk in Rooks county. Twenty-one hawks of this species were banded by the writer from November, 1935, to February, 1936, inclusive. Skin of one immature male in writer's collection.

Buteo regalis. Ferruginous Rough-leg. Squirrel Hawk.
Occasional resident. Common in winter. One male skin in writer's collection.

Aquila chrysaëtos canadensis. Golden Eagle.
Fairly common winter resident. Golden eagles roost in the rocky bluffs and will return to the same tree throughout the winter unless disturbed. Three have been roosting this winter in a small group of scrubby trees on the northern slope of a rocky ravine about five miles from Stockton. Thorough examination of this roost was made, but no pellets were found. April 18 was the last observation of golden eagles in the spring of 1936. They were first seen in the fall on October 29, but may have been here earlier.

Haliaeetus leucocephalus leucocephalus. Southern Bald Eagle.
Fairly common winter resident. In December, 1931, I counted twenty-one bald eagles where they were roosting along the Solomon river in a grove of tall cottonwoods. They were all in the roost at once and were counted as they left. In January, 1936, sixteen birds were in this same roost. February 23, 1936, nine were counted. Many pellets have been picked up under this roost during the winter of 1935-'36. They have been sent to the Food Habits Division of the Biological Survey for analysis. Many careful observations have been made, but golden eagles have never been seen at this roost, although they are common in the surrounding area. A mounted bald eagle, which was wantonly shot by hunters, is in the collection of the writer.

Circus hudsonius. Marsh Hawk.
Common resident. This is the only hawk that is common throughout the year in Rooks county. Marsh hawks were very uncommon during the drought of 1934, but became common again in 1935. Six were in sight at one time on April 6, 1936. They were hunting over a waste field.

Family FALCONIDAE. Falcons.

Falco mexicanus. Prairie Falcon.
Occasional. Individuals were seen December 11 and December 21, 1935. Skin of specimen found dead February 23, 1936, is in writer's collection.

Falco peregrinus anatum. Duck Hawk.
A male was shot near Stockton in the spring of 1933.

Falco sparverius sparverius. Eastern Sparrow Hawk.
Fairly common summer resident. Occasional during most of the winter. Abundant in migration. During the severe winter of 1935-'36 no sparrow hawks were seen between October 26 and March 19.

Family TETRAONIDAE. Grouse.

Tympanuchus pallidicinctus. Lesser Prairie Chicken.
Occasional resident in undisturbed grasslands.

Family PERDICIDAE. Partridges.

Colinus virginianus virginianus. Eastern Bobwhite.
Fairly common resident until 1934. The drought and dust storms have made them quite uncommon.

Family PHASIANIDAE. Pheasants.

Phasianus colchicus torquatus. Ring-necked Pheasant.
Resident. Common until 1934. I saw only two pheasants during the entire year of 1935. Many of the comparatively tame birds were shot in 1934, which was the first open season in Rooks county. The dust storms of 1935 killed most of those left.

Chrysolophus pictus. Golden Pheasant.
One cock was seen in the fall of 1933 near Codell.

Family GRUIDAE. Cranes.

Grus americana. Whooping Crane.
An individual was reported in Graham county in the spring of 1929.

Grus canadensis canadensis. Little Brown Crane.
A specimen shot in fall of 1930 in writer's collection.

Grus canadensis tabida. Sandhill Crane.
Migrant. Fifty-eight cranes were seen in one flock March 28, 1935. In the fall flight of 1935 as many as six flocks of cranes were seen in one day.

Family RALLIDAE. Rails.

Rallus limicola limicola. Virginia Rail.
One was caught by a cat in Plainville in September, 1933.

Porzana carolina. Sora.
A sora was caught in Ellis county in 1927 and brought to Doctor Wooster. Another, which is in the writer's collection, was found dead in Stockton, September 12, 1935.

Fulica americana americana. American Coot. Mudhen.
Common migrant. At times abundant.

Family CHARADRIIDAE. Plovers.

Oxyechus vociferus vociferus. Killdeer.
Common summer resident. Abundant in migration. About 150 of these birds were seen near one large pond October 26, 1935. Killdeers usually leave in November and return in March, although I have records of them for all months except January.

Family SCOLOPACIDAE. Sandpipers, Snipes.

Capella delicata. Wilson's Snipe.
Occasional migrant.

Numenius americanus americanus. Long-billed Curlew.
Rare migrant. Two were shot by hunters April 16, 1933.

Bartramia longicauda. Upland Plover.
Quite common in spring and fall. Their plaintive call is often heard at night.

Actitis macularia. Spotted Sandpiper.
Fairly common during migration.

Tringa solitaria subsp. Solitary Sandpiper.
Fairly common in migration.

Totanus melanoleucus. Greater Yellow-legs.
Occasionally seen in migration.

Totanus flavipes. Lesser Yellow-legs.
Not uncommon in migration.

Pisobia bairdi. Baird's Sandpiper.
Very common in migration. Two skins in writer's collection were taken March 26, 1936.

Pisobia minutilla. Least Sandpiper.
Common migrant.

Micropalama himantopus. Stilt Sandpiper.
A skin in writer's collection was shot March 21, 1935.

Family RECURVIROSTRIDAE. Avocets, Stilts.

Recurvirostra americana. Avocet.
Two were shot by hunters during the spring migration of 1935.

Family PHALAROPODIDAE. Phalaropes.

Steganopus tricolor. Wilson's Phalarope.
Common migrant. Four observed May 7, 1933.

Family LARIDAE. Gulls, Terns.

Larus delawarensis. Ring-billed Gull.
Occasional migrant. One skin taken April 9, 1933, in writer's collection.

Larus pipixcan. Franklin's Gull.
Common migrant. Occasionally abundant. One in writer's collection taken April 20, 1933. It was gorged with cutworms which were doing much damage to wheat at this time. Thirty in one flock were observed April 7, 1936.

Sterna antillarum antillarum. Least Tern.
Rare migrant. One taken in spring of 1933 in writer's collection.

Chlidonias nigra surinamensis. Black Tern.
Fairly common in migration. Black terns are usually seen with Franklin's gulls.

Family COLUMBIDAE. Doves.

Zenaidura macroura marginella. Western Mourning Dove.
Abundant summer resident. Rare winter resident. Usually common by the middle of April. A flock of at least 25 observed February 10, 1936.

Family CUCULIDAE. Cuckoos.

Coccyzus americanus americanus. Yellow-billed Cuckoo.
Fairly common summer resident. Arrives late in May.

Family Tytonidae. Barn Owls.

Tyto alba pratincola. Barn Owl.
Fairly common. Usually nests in holes in clay or shale banks.

Family Strigidae. Owls.

Otus asio naevius. Eastern Screech Owl.
Common resident. Red phase occasionally seen. One skin in writer's collection.

Bubo virginianus virginianus. Great Horned Owl.
Common resident. Nine great horned owls were handled by the writer during the past year. Seven were distinctly this subspecies.

Bubo virginianus occidentalis. Montana Horned Owl.
Not common. One specimen of this subspecies was killed near Stockton in the fall of 1933 and mounted. Another was shot February 22, 1936. It is in writer's collection.

Nyctea nyctea. Snowy Owl.
Rare winter straggler. One of these was seen in Graham county in 1929. H. C. Sweet, of Stockton, has a specimen that was killed in Rooks county in January, 1913, during a severe winter.

Speotyto cunicularia hypugaea. Burrowing Owl.
Common summer resident. The writer has been observing the owls in a prairie-dog town near Stockton. The latest fall record in 1935 was October 29. The first this spring was March 28. They were common by the middle of April.

Asio wilsonianus. Long-eared Owl.
Occasional. Sometimes common in migration.

Asio flammeus flammeus. Short-eared Owl.
Occasional. At times quite common in migration. A specimen was shot November 7, 1935.

Cryptoglaux acadica acadica. Saw-whet Owl.
Seen once in Graham county. Collected one in Rooks county, December 26, 1933. Both were in the timber along the Solomon river.

Family Caprimulgidae. Nighthawks.

Phalaenoptilus nuttalli nuttalli. Nuttall's Poor Will.
Caught one in Ellis county, July 20, 1929. It appeared to be at home on a large shale slope on the Saline river.

Chordeiles minor subsp. Nighthawk.
Common summer resident from May to October.

Family Trochilidae. Hummingbirds.

Archilochus colubris. Ruby-throated Hummingbird.
Occasional. In Ellis county Doctor Wooster saw one on September 22, and one on September 23, 1927. He captured another in the fall of 1934.

Family Alcedinidae. Kingfishers.

Megaceryle alcyon alcyon. Belted Kingfisher.
Fairly common summer resident along streams. Rare in winter.

Family PICIDAE. Woodpeckers.

Colaptes auratus luteus. Northern Flicker.

Common summer resident. Very rare, if here at all, in midwinter. One was caught and banded November 25, 1935. Hybridizes with *C. cafer collaris.* A flicker collected in the spring of 1928 had red malar patches instead of black, while the yellow flight feathers had a tinge of pink. Normal male and hybrid male skins in writer's collection.

Colaptes cafer collaris. Red-shafted Flicker.

Common winter resident. Rooks county is near the eastern limit of the regular range of this bird in Kansas. In December, 1935, it was common in Rooks county but no northern flickers were to be seen. On December 22 and 23, 1935, the writer took an extensive bird census in Geary county, which is 150 miles east of Rooks county, and found the northern flickers common, but no red-shafted flickers were seen.

Centurus carolinus. Red-bellied Woodpecker.

Occasional. An individual was seen several times during the winter of 1932-'33 along the Solomon river. It was last seen on April 7, 1933. Three were seen at one time on March 8, 1936. A pair taken at Junction City, Kan., is in the writer's collection.

Melanerpes erythrocephalus. Redheaded Woodpecker.

Common summer resident. Arrives in May.

Sphyrapicus varius varius. Yellow-bellied Sapsucker.

Rare. A male was seen March 26, 1935. In January, 1933, one did much damage to a large pine tree in Stockton. It lived on the tree for about eight days. Eight hundred sixteen holes were counted in three feet of the tree trunk. The lowest holes were about six feet from the ground.

Dryobates villosus villosus. Eastern Hairy Woodpecker.

Common resident. Apparently more common than usual during the winter of 1935-'36. One skin in writer's collection.

Dryobates pubescens medianus. Northern Downy Woodpecker.

Common resident. A pair taken February 22, 1936, in writer's collection.

Family TYRANNIDAE. Flycatchers.

Tyrannus tyrannus. Eastern Kingbird.

Common summer resident. Earliest and latest dates for 1935 were May 4 and September 7. Seen in 1933 on April 29.

Tyrannus verticalis. Arkansas Kingbird. Western Kingbird.

Abundant summer resident. Early records: April 20, 1933, April 25, 1935. Last record in 1935 was September 25. One skin in writer's collection.

Muscivora forficata. Scissor-tailed Flycatcher.

Rare. The only record for this species was an individual seen flying over the Stockton Golf Course May 2, 1934.

Myiarchus crinitus boreus. Northern Crested Flycatcher.

Common summer resident along the Solomon river. Arrives early in May. A male collected May 20, 1936, in writer's collection.

Sayornis phoebe. Eastern Phoebe.

Uncommon summer resident. A pair nested under a bridge three miles west of Stockton for at least two years.

Sayornis saya saya. Say's Phoebe.
Rare. I have seen it here only in spring.

Empidonax minimus. Least Flycatcher.
Migrant. These birds were common along the Solomon river May 17 to 19, 1935. One taken May 20, 1935, in writer's collection.

Myiochanes virens. Eastern Wood Pewee.
Occasional in migration.

Family ALAUIDAE. Larks.

Otocoris alpestris hoyti. Hoyt's Horned Lark.
Not common. A specimen taken December 14, 1935, in writer's collection.

Otocoris alpestris praticola. Prairie Horned Lark.
Not common. One collected January 20, 1936, in writer's collection.

Otocoris alpestris leucolaema. Desert Horned Lark.
Common resident. Abundant in winter on the upland prairies. Several skins of this subspecies in writer's collection. These, and the skins of the preceding subspecies have been determined by Oberholser.

Family HIRUNDINIDAE. Swallows.

Iridoprocne bicolor. Tree Swallow.
Fairly common in migration. On May 19, 1935, a flock of at least 120 swallows was seen near a temporary pond just after a heavy rain. The flock was mostly cliff swallows, but many were barn swallows, and at least three were tree swallows.

Riparia riparia riparia. Bank Swallow.
Fairy common summer resident. Arrives late in April.

Stelgidopteryx ruficollis serripennis. Rough-winged Swallow.
Occasional.

Hirundo erythrogaster. Barn Swallow.
Common summer resident from May to September.

Petrochelidon albifrons albifrons. Cliff Swallow.
Summer resident in suitable localities. Colonies are occasionally found nesting under projecting limestone cliffs. At least twenty pairs nest under a concrete structure rising from the center of a bathing pool in Ellis county. Concrete bridges are occasionally used for nesting sites and Dr. L. D. Wooster has found their nests attached to a stone schoolhouse in Gove county, Kansas.

Progne subis subis. Purple Martin.
Occasional summer resident. In the summer of 1930 purple martins nested in two building fronts on the main street of Stockton. They have not nested in Stockton for at least three years.

Family CORVIDAE. Crows.

Cyanocitta cristata cristata. Blue Jay.
Common summer resident from April to October. Rare winter sojourner along rivers. One was seen February 16, 1936.

Pica pica hudsonia. Magpie.
Occasional winter sojourner. A flock of at least 50 magpies was seen several times in December, 1934, near Stockton.

Corvus brachyrhynchos brachyrhynchos. Eastern Crow.
Common resident. Very abundant in fall migrations. Crows were uncommon during the winter of 1935-'36 until late in February when they suddenly became common again. The crows here average about eighteen inches in length.

Cyanocephalus cyanocephalus. Piñon Jay.
Rare winter sojourner. One skin taken in December, 1930, in writer's collection.

Family PARIDAE. Titmice.

Penthestes atricapillus atricapillus. Black-capped Chickadee.
Common resident. Of seven chickadees taken near Stockton during the winter of 1935-'36 five were of this subspecies, and two were *P. a. septentrionalis.* Of three taken in Geary county one was *P. a. septentrionalis.* Several of the ten specimens showed tendencies toward intergrading. Several chickadee skins are in the writer's collection.

Penthestes aricapillus septentrionalis. Long-tailed Chickadee.
Not common. Two skins in writer's collection.

Family SITTIDAE. Nuthatches.

Sitta carolinensis carolinensis. White-breasted Nuthatch.
Rare. Two winter records. One was seen December 22, 1933.

Sitta canadensis. Red-breasted Nuthatch.
One record. A female was seen December 15, 1935, in the timber along the Solomon river.

Family CERTHIIDAE. Creepers.

Certhia familiaris montana. Rocky Mountain Creeper.
Uncommon winter sojourner. One skin in writer's collection.

Family TROGLODYTIDAE. Wrens.

Troglodytes aedon parkmani. Western House Wren.
Common summer resident. Arrives in April.

Thryothorus ludovicianus ludovicianus. Carolina Wren.
This wren was seen only twice in Rooks county and each time in midwinter.

Salpinctes obsoletus obsoletus. Rock Wren.
Fairly common summer resident in suitable localities. Three were seen March 26, 1927, in rock cliffs where they were evidently settled for the summer.

Family MIMIDAE. Mockers.

Mimus polyglottos leucopterus. Western Mockingbird.
Common summer resident. Two stayed on the Fort Hays State College campus at Hays, Kan., for most of the winter of 1927-'28. Ordinarily they arrive in April and leave in October.

Dumetella carolinensis. Catbird.
Fairly common summer resident. Arrives in May.

Toxostoma rufum. Brown Thrasher.
Common summer resident from April to September.

Family Turdidae. Thrushes.

Turdus migratorius migratorius. Robin.

Abundant summer resident. Robins are not uncommon along streams during ordinary winters. Not seen from November until February 4, during the present winter, which has been much colder than normal. A flock of 52 robins was seen flying north March 1, 1936.

Turdus migratorius propinquus. Western Robin.

Occasional in winter and in migration. Three skins in writer's collection. Two females taken March 22, 1936, differ considerably in color.

Hylocichla mustelina. Wood Thrush.

Seen occasionally in migration. Doctor Wooster says that they nested regularly on the college campus at Hays, Kan., in former years. He found their nest on two successive seasons.

Hylocichla guttata faxoni. Eastern Hermit Thrush.

Migrant, not common. One skin taken in May, 1932.

Hylocichla ustulata swainsoni. Olive-backed Thrush.

Migrant. The olive-backed thrush is usually abundant here for about two weeks in May. Two skins in writer's collection.

Hylocichla ustulata almae. Alma Thrush.

A male in the writer's collection, taken May 20, 1935, was determined by Oberholser.

Sialia sialis sialis. Bluebird.

Occasional summer resident. Rare in winter. One was observed February 16, 1936. Two skins in the writer's collection.

Sialia currucoides. Mountain Bluebird.

One was seen in March, 1933. They are recorded almost every spring in Ellis county by Wooster.

Myadestes townsendi. Townsend Solitaire.

Occasional winter sojourner from October to April. One was seen on April 6, 1927, in Ellis county. One skin taken in Rooks county is in the writer's collection. Another was seen December 7, 1935.

Family Sylviidae. Kinglets, Gnatcatchers.

Polioptila caerulea caerulea. Blue-gray Gnatcatcher.

One record in spring migration in Ellis county. A skin in writer's collection taken at Junction City, Kan., May 26, 1935.

Regulus satrapa satrapa. Eastern Golden-crowned Kinglet.

Rare winter sojourner and migrant. One skin taken March 15, 1936, in writer's collection.

Regulus calendula calendula. Ruby-crowned Kinglet.

Rare in winter. Occasional in migration. A skin taken March 29, 1936, in writer's collection.

Family Motacillidae. Pipits.

Anthus spraguei. Sprague's pipit.

Migrant. A specimen was found freshly killed on the highway on April 26, 1933.

Family Bombycillidae. Waxwings.

Bombycilla garrula pallidiceps. Bohemian Waxwing.

Rare winter visitant. A flock of fifteen was seen on the Fort Hays State College campus December 25, 1926. They were not seen again during the winter, although cedar waxwings were common. Bohemian waxwings were seen several times in Stockton during the winter of 1931-'32 but have not been seen since. One skin taken at that time in writer's collection.

Bombycilla cedrorum. Cedar Waxwing.

Fairly common winter visitant. At times abundant. As many as sixty-seven have been counted at one time in Stockton. I have no nesting records, although I have seen cedar waxwings as late as June. Two skins in writer's collection.

Family Laniidae. Shrikes.

Lanius borealis. Northern Shrike.

Winter visitant. Rare in Rooks county, but Wooster writes that it is not uncommon in Ellis county.

Lanius ludovicianus excubitorides. White-rumped Shrike.

Fairly common summer resident. The first record in 1935 was March 29.

Family Vireonidae. Vireos.

Vireo griseus griseus. White-eyed Vireo.

Seen once in spring in Ellis county.

Vireo belli belli. Bell's Vireo.

Summer resident. Common in plum brush along river.

Vireo olivaceus. Red-eyed Vireo.

Fairly common resident along timbered streams during the summer of 1935. This bird was not noted here before 1935. A female in the writer's collection was collected at Junction City, Kan., May 26, 1936.

Vireo gilvus subsp. Warbling Vireo.

Fairly common summer resident from late April to September.

Family Compsothlypidae. Wood Warblers.

Mniotilta varia. Black and White Warbler.

Rare migrant. Seen in Hays, Ellis county, May 6, 1927, and Stockton, Rook county, May 21, 1935.

Vermivora peregrina. Tennessee Warbler.

Occasional migrant.

Vermivora celata celata. Orange-crowned Warbler.

Migrant. One skin in writer's collection.

Dendroica aestiva aestiva. Eastern Yellow Warbler.

Common summer resident. Arrives early in May. Two skins of this species taken May 20 and 26, 1935, in writer's collection.

Dendroica magnolia. Magnolia Warbler.

Rare migrant. The only record of this species was a male seen May 21, 1935. It was in a migrating group which also contained two redstarts, one mourning warbler, one ovenbird, one black and white warbler, and several yellow warblers and yellow-throats.

Dendroica coronata. Myrtle Warbler.
Abundant in migration. Rare winter sojourner.

Dendroica auduboni auduboni. Audubón's Warbler.
Rare migrant.

Dendroica striata. Blackpoll Warbler.
Common migrant in May. One male collected May 20, 1933, in writer's collection.

Seiurus aurocapillus. Ovenbird.
Occasional migrant in May.

Oporornis philadelphia. Mourning Warbler.
One record: May 21, 1935.

Geothlypis trichas occidentalis. Western Yellow-throat.
Fairly common in migration. Yellow-throats were unusually abundant in May, 1935.

Icteria virens longicauda. Long-tailed Chat.
A male was found dead in Hays, Ellis county, May 24, 1935.

Setophaga ruticilla. American Redstart.
Rare migrant. In 1935 a pair was seen on May 18, and another pair on May 21.

Family Ploceidae. Weaver Finches.

Passer domesticus domesticus. English Sparrow.
Abundant resident about town and farm buildings.

Family Icteridae. Blackbirds, Orioles.

Dolichonyx oryzivorus. Bobolink.
One record. A female in the writer's collection was taken May 20, 1935.

Sturnella neglecta. Western Meadowlark.
Common resident. Often seen in large scattered flocks in fall and winter where food is plentiful. On October 26, 1935, a warm sunny day, two large flocks, estimated at 70 and 125, were seen in separate places. Their singing was so vigorous that it could be heard a quarter of a mile distant.

Zanthocephalus zanthocephalus. Yellow-headed Blackbird.
Fairly common in migration. Abundant early in May, 1935. A male taken in fall in writer's collection.

Agelaius phoeniceus phoeniceus. Red-winged Blackbird.
Common summer resident. Occasional in late fall. Redwings were first seen in 1935 on February 27. In 1936 the earliest record was March 1. One skin of this subspecies in writer's collection.

Agelaius phoeniceus fortis. Thick-billed Redwing.
Common in migration. Several skins in writer's collection.

Icterus spurius. Orchard Oriole.
Common summer resident from April to August.

Icterus galbula. Baltimore Oriole.
Common summer resident from early May to September. One male skin in writer's collection.

Icterus bullocki. Bullock's Oriole.

Two May records at Oakley, Logan county, Kansas. Not observed in Rooks county.

Euphagus carolinus. Rusty Blackbird.

A flock of five was observed February 16, 1936. A female skin in the writer's collection was shot from a flock of three, March 8, 1936. Another was collected March 15, 1936.

Euphagus cyanocephalus. Brewer's Blackbird.

Occasional. A pair in the writer's collection was shot March 8, 1936. Nine were observed singing on this date.

Quiscalus quiscula aeneus. Bronzed Grackle.

Abundant summer resident. Stragglers are seen until December. The first 1936 record was March 29.

Molothrus ater ater. Cowbird.

Fairly common summer resident. Arrives in April.

Family FRINGILLIDAE. Grosbeaks, Sparrows, Etc.

Richmondena cardinalis cardinalis. Cardinal.

Resident. Occasional along streams where there is timber.

Hedymeles ludovicianus. Rose-breasted Grosbeak.

Rare migrant. A male was seen April 25, 1936. Another was seen at Hays, Kan., May 3, 1927. A male skin taken at Junction City, Kan., May 26, 1935, is in the writer's collection.

Hedymeles melanocephalus papago. Rocky Mountain Grosbeak.

Common summer resident. Arrives in April. In 1935 first seen April 25.

Guiraca caerulea interfusa. Western Blue Grosbeak.

Occasional summer resident. In 1935 first seen April 26. A male collected near Sylvan Grove, Kan., May 24, 1935, is in the writer's collection.

Passerina cyanea. Indigo Bunting.

Rare migrant. Two males were seen May 21, 1935. Two days later one male was seen in the same locality. These are my only records in Rooks county.

Passerina amoena. Lazula Bunting.

One record. Two males and three females were seen May 21, 1935, with the two indigo buntings mentioned above.

Spiza americana. Dickcissel.

Fairly common summer resident until 1933. Dickcissels were very rare, if here at all, during the summer of 1934 (the drought year); and although they were seen in 1935 they were still uncommon until late in June. It is known that these birds were more common than usual in Colorado during the drought here (G. Alexander, Condor, 37:38, 1935.) Dr. L. D. Wooster states in his journal that he saw seven dickcissels in a mile drive on June 26, 1935, near Hays, in Ellis county. These were the first he had seen on this regular drive in two years.

Hesperiphona vespertina vespertina. Evening Grosbeak.

One record. An evening grosbeak was seen daily in Stockton from December 11 to 15, 1933.

Spinus pinus pinus. Pine Siskin.
Occasional winter sojourner. At times abundant. In the spring of 1927 siskins built a complete nest in a red cedar in Ellis county but never laid eggs in it. Seven were seen feeding on sunflower heads December 15, 1935.

Spinus tristis tristis. Goldfinch.
Occasional in summer. More common in migration and winter. A female taken January 12, 1936, in writer's collection.

Pipilo erythrophthalmus erythrophthalmus. Red-eyed Towhee.
Occasional migrant.

Pipilo maculatus arcticus. Arctic Towhee.
Common migrant. Rare winter sojourner.

Calamospiza melanocorys. Lark Bunting.
Common spring migrant. Rare summer resident. Two nests were found in Ellis county, June 24, 1935. Both contained fresh eggs. The birds no doubt nested in Rooks county at this time as they were common there, too. This is my only record of Lark Buntings nesting in this vicinity, although it is not over one hundred miles west to their common nesting range.

Passerculus sandwichensis subsp. Savanna Sparrow.
Occasional during migration.

Ammodramus savannarum bimaculatus. Western Grasshopper Sparrow.
Common summer resident.

Pooecetes gramineus confinis. Western Vesper Sparrow.
Fairly common during migration. Arrives late in April.

Chondestes grammacus strigatus. Western Lark Sparrow.
Common summer resident. Arrives in April. Nests in low bushes and on the ground. Several nests have been found in small evergreens on the campus at Fort Hays State College.

Junco hyemalis hyemalis. Slate-colored Junco.
Common winter resident from November to April.

Junco oreganus shufeldti. Shufeldt Junco.
Occasionally seen during the winter. Two skins of this subspecies in writer's collection.

Spizella monticola ochracea. Western Tree Sparrow.
Very abundant winter resident in plum thickets and tall weeds. This is our most common winter bird from late October to March. Two skins collected February 9, 1936.

Spizella passerina subsp. Chipping Sparrow.
Common migrant. First seen in 1935 on April 24.

Spizella pallida. Clay-colored Sparrow.
Abundant migrant. April 24 was the peak of the 1935 flight. This species is usually in company with Chipping Sparrows but is generally more abundant than the latter.

Spizella pusilla subsp. Field Sparrow.
Occasional in migration.

Zonotrichia querula. Harris's Sparrow.
Common winter resident from October to May. Three skins in the writer's collection.

Zonotrichia leucophrys leucophrys. White-crowned Sparrow.
Common migrant. Sometimes abundant in spring migration late in April

Zonotrichia leucophrys gambeli. Gambel's Sparrow.
One skin in the writer's collection taken April 20, 1933.

Zonotrichia albicollis. White-throated Sparrow.
In Ellis county Wooster saw one on April 25, 1928, and three on April 27, 1928.

Melospiza lincolni lincolni. Lincoln's Sparrow.
Fairly common migrant. One skin in the writer's collection taken May 18, 1935.

Melospiza melodia juddi. Dakota Song Sparrow.
Common winter resident and common in migration. On January 12, 1936, nine were counted on a tramp of about a mile along the river. They were about this common for most of the winter. One skin collected February 22, 1936, in writer's collection.

Calcarius lapponicus lapponicus. Lapland Longspur.
Abundant winter sojourner. Often found in flocks of two hundred or more on the upland prairies in the coldest winter weather. Large numbers of this bird are occasionally killed in the streets at night during snowstorms. When the snow starts falling in the daytime and continues during the night the birds seem to be attracted by the lights and fly into the streets. February 3, 1936, after such a night, I picked up thirty-seven dead birds and three crippled birds on the main street of Stockton. I have two other records of such occurrences. I have collected no other longspurs except the following subspecies in Rooks county and I believe no others are commonly found here. Six skins in writer's collection.

Calcarius lapponicus alascensis. Alaskan Longspur.
Two skins taken by the writer were identified by Oberholser as this subspecies. The skins were almost inseparable from the preceding subspecies.

Plectrophenax nivalis nivalis. Snow Bunting.
One record. Fourteen were seen January, 1933, in one flock.

A Study of the Myology and Osteology of Tree Sciurids With Regard to Adaptation to Arboreal, Glissant and Fossorial Habits[1]

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INTRODUCTION

The main object of this work is to show the adaptations in myology (the study of muscles) and osteology (the study of bones) that have resulted from habits and environment in a closely related group. The musculature is emphasized, but it is obvious that a problem of this kind would be inadequate without consideration of the bony levers, projections, relative and proportional lengths of the bones, and the part they play in the economy of the animal. In other words the two are so closely related that they cannot be treated separately with any sense of security.

It is also hoped that the anatomy of the muscles of the different forms as herein described represents a contribution that heretofore has been neglected. Howell's Anatomy of the Wood Rat is the only reliable work published on the myology of a generalized rodent, and was freely consulted, especially as regards nomenclature.

MATERIAL AND METHODS

Of most importance is the selection of the material for this type of work. In studying the variations caused by adaptation it is particularly advantageous to choose a group of related forms, thereby eliminating undesirable phylogenetic factors which might complicate the problem or be a source of error.

The types chosen are of the family Sciuridae and include the species *Sciurus niger rufiventer*, *Glaucomys volans querceti* and *Cynomys ludovicianus ludovicianus*. The first represents a partially arboreal type and is known as the common fox squirrel. The second represents the gliding or glissant type of adaptation and is known as the "flying" squirrel. The third represents a partially fossorial type of prairie dog. As a basis for comparison the common brown rat *Epimys norvegicus* was selected. This form represents a generalized terrestrial or surface-dwelling type. For simplicity the common names are used throughout this work.

This group, exclusive of the rat, illustrates adaptative radiation. The arboreal squirrel can be taken as the most primitive form, from which the other two have diverged. Such a group offers ideal material for the study of this type of problem. The arboreal squirrel and prairie dog, however, offer some difficulty, in that they have undergone a dual adaptation. For instance, the arboreal squirrel is terrestrial as well as arboreal. The prairie dog is not only fossorial but also fairly well adapted for terrestrial life. This makes for a condition that would tend to cause convergence of structures in the adaptations that they have in common. Furthermore, the musculature needed to bring about a certain movement in the different adaptations may be al-

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1. Essentials from a dissertation in partial fulfillment of the degree, Doctor of Philosophy, at University of Kansas.

most identical. For example, the flexors of the thoracic limb of the arboreal squirrel need to be almost equally as well developed in climbing and drawing the body upward as in prairie dog for its digging habits. Nevertheless, the differences are distinctive in the majority of cases. The flying squirrel, on the other hand, is the most specialized of the group, and this tends to obviate some of the difficulties.

The number of specimens dissected include five prairie dogs purchased in Kansas City, Mo.; twelve flying squirrels from a supply house in Florida; four flying squirrels (*Glaucomys volans volans*), from Arkansas; fourteen rats and nine arboreal squirrels taken in Lawrence, Kan., or immediate vicinity. For purposes of verifying some of the trends observed, portions of the following animals were also dissected: The common mole (*Scalopus aquaticus machrinoides*); the pocket gopher (*Geomys bursarius*); the cotton-tail rabbit (*Sylvilagus floridanus mearnsi*).

The habits of all the animals except the flying squirrel were studied both in their native habitats and in captivity. The flying squirrel was studied in captivity only.

After killing the animals they were placed in a twenty-percent solution of formalin for about three weeks, in order to set the muscles. Many of the specimens were skinned before placing in the preservative. This proved to be a good opportunity to study the muscles of the skin. From the formalin they were placed permanently into a saturated brine solution.

The muscles of the rat were studied first. In this process all excess fat and fascia were removed. The muscles were carefully isolated and the attachments noted. These were then compared to the other forms. In no instance was any result recorded until at least three specimens of each were dissected. For the small muscles of the hand and forearm the dissecting microscope was necessary, and many more specimens of each were used.

The muscles were arranged in order with respect to function, rather than the arrangements seen in most books on anatomy. A discussion follows each group.

Volumes of all the muscles were taken in order to determine the relative sizes in all the specimens dissected. Muscles comprising a group having the same function were compared, either to the total body or to a portion of it, as was seen fit.

The technique in determining the volumes was as follows: The specimen was taken from the brine solution and skinned, if this had not already been done. It was then placed in a graduate containing the same brine solution in which it was preserved, and the amount of fluid displaced was recorded. This precaution of using the same fluid was taken in order to prevent any absorption or loss of liquid from the tissues. The muscles of a functional group, such as the pelvic limb, were removed from the body, together with its bones and the volume taken. The individual muscles were then carefully detached and the volumes taken in appropriate graduates and compared in this case to the total volume of the pelvic limb. About ninety-four percent of the musculature and bones could be accounted for in this way. The remaining six percent was lost, due to the removal of the fat, blood vessels and fascia before taking the volumes. Each muscle and muscle group was checked at least three or four times and the average taken, thus reducing the probable error to a minimum. All determinations are recorded as percentages.

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HABITS

The rat is one of the most successful and adaptable rodents. It is very plentiful in the cities, waterfronts and less settled districts. It is also found inhabiting fields and other places affording food and shelter. In fact, it has followed man until its distribution is almost universal.

Its food consists mostly of grains and garbage, but it will eat practically anything that has any food value. The nest is usually made beneath a building, under a rock pile or in a shallow burrow. The material consists of any old rags, cotton, feathers, grass, and paper, that happen to be in the vicinity. The rat is an excellent gnawer, and has been known even to gnaw through metal. If necessity arises it is also a good climber and burrower.

The arboreal squirrels used in this work were all taken in Douglas county, near Lawrence, Kan. The most favored localities appear to be hilly and wooded, but one is apt to find them in any roadside group of trees.

For a den the squirrel frequently takes over a woodpecker's or flicker's nest. If these are not available it makes its own by gnawing a hole in a hollow tree. This type of nest is used during the winter and while caring for the young. During warm weather it usually abandons the winter den and builds a nest of twigs and leaves in a treetop. The nest may be roofed over or open. This species does not hibernate. It is a very good climber but spends a considerable part of its time on the ground, mostly in search of food. In running through the branches of the trees, it takes long jumps from limb to limb. These squirrels are never known to migrate in great numbers. The food consists chiefly of black walnuts, acorns, seeds of most trees, buds, bark, corn and a great number of other things, including occasionally the eggs and young of birds. The nuts, especially, are stored for the winter. This is done by digging many shallow pits and depositing one or only a few in each pit and then covering.

The species of flying squirrel employed in this study is the Florida form. They are gregarious and where found are usually plentiful. As with the arboreal squirrel, the favorite place for a den is an abandoned woodpecker's nest. Many times they are known to make their nests of leaves and twigs up in a crotch or branches of a tree; and if near a building, build their nests in a secluded place within it.

A. H. Howell, 1918, says, regarding their habits, as follows: "Flying squirrels are almost exclusively arboreal, seldom descending to the ground and apparently never running for any distance on its surface. They are unsuspicious, and being easily tamed, make very attractive pets. Possessed of intense activity, their movements are the acme of grace and agility. They do not fly

in the usual sense of the term, but progress from tree to tree by gliding with outstretched membranes from an elevated position to a point lower down, usually near the ground. Just before alighting the animal checks its momentum by sweeping upward in a gentle curve and alights on the tree trunk with its head up. Ascending the tree by climbing, it is ready for another flight. In these gliding leaps, which may extend for a distance of 50 yards or more, the squirrel is able to change its course to one side or the other with perfect ease.

"Unlike all other American squirrels, the flying squirrels are strictly nocturnal. During the daytime they remain concealed in their nests and are never seen abroad unless frightened from their retreats. Usually they may be driven readily from their holes by pounding with an ax or club on the base of the tree in which they are sleeping. Woodchoppers frequently scare them out when felling timber, and anyone who camps frequently in the woods is likely to hear them at night running or jumping about in the trees or dropping nuts to the ground."

The food eaten is very similar to that of the arboreal squirrel and includes nuts, buds, seeds and berries. They also have a special liking for beetles, young birds and eggs. Hoarding is done to a greater extent than with the arboreal squirrel.

The prairie dog is an inhabitant of the Great Plains region. The particular species studied is from western Kansas. They are very gregarious and thousands of them may live in "villages" extending many miles in area. The burrow is almost vertical to a depth of at least twelve to fourteen feet, from which there are extensive ramifications in all directions. The outer rim of the burrow usually is large, especially during periods of heavy rainfall. The mounds are made by pushing and packing the earth with the head. Repairs are very frequent. It is thought that the earth is brought to the surface in the armpits. They usually confine themselves to the immediate vicinity of their villages, but the whole population of a town is known to migrate long distance without any apparent reason. The prairie dog is a lover of sunshine and is usually seen perched on its haunches near its burrow. The food is primarily vegetable, and includes grasses of every kind, small shrubs, crops and vegetables. They cause considerable damage to grazing lands and crops where permitted to live. During a drought they clear the land until it is barren of vegetation. In captivity the prairie dog is also fond of table scraps. Pieces of the food are carried to the mouth with the hands, and are clumsily manipulated while being eaten.

SUMMARY

Tabulation of Myological Differences in the Forms Studied

Muscle.	Rat.	Arboreal squirrel.	Flying squirrel.	Prairie dog.
Flexor brevis pollicis	Normal.	Normal.	Smaller.	Normal.
Adductor digiti quinti	Normal.	Fused to adductor indicis, smaller.	Longer tendon.	As in arboreal squirrel.
Adductor digiti quinti	Normal.	Normal.	Originates mostly from the surface of capitatum magnum.	Larger, originates from a broader surface.
Adductor pollicis	Normal.	Larger.	Absent.	Normal.
Lumbricales	Normal.	Fourth lumbricale is bifurcated.	First lumbricale originates in the angle of first and second tendon.	First lumbricale is absent.
Interossei	Normal in number, but originate from oval plate of cartilage.	Originate from carpal bones, most ulnar interosseus not fused to adductor digiti quinti.	As in arboreal squirrel.	As in arboreal squirrel. Tendinous extensions more definite.
Adductor digiti secundi	Passes from base of radial interosseus of the third digit, to first phalanx of second digit.	Absent.	Absent.	Absent.
Adductor brevis pollicis	Normal.	Smaller.	Smaller.	Larger.
Flexor brevis pollicis	Normal.	Smaller.	Normal.	Normal.
Palmaris brevis	Normal.	More muscular.	Portion of it originates from surface of styli-form cartilage.	Normal.
Adductor indicis	Normal.	Fused to abductor digiti quinti.	Longer tendon.	Normal.
Extensor carpi radialis longus	Normal.	Normal.	Normal.	Normal.

Muscle.	Rat.	Arboreal squirrel.	Flying squirrel.	Prairie dog.
Extensor carpi radialis brevis	Normal.	Normal.	Normal.	Normal.
Extensor carpi ulnaris	Normal.	Insertion is ventral upon base of metacarpus five.	Origin mostly from ulna distal to the lateral epicondyle.	Normal.
Extensor	Normal.	Normal.	Normal.	Additional tendinous slip is inserted upon digit one.
Extensor digitorum communis	Normal.	Normal.	Normal.	Tendons connected by a tendinous vincula.
Pronator teres	Normal.	Normal.	Larger.	Normal.
Extensor digiti quinti	Normal.	Two parts.	Originates mostly upon extensor digitorum communis.	Tendons are bifurcated.
Extensor metacarpi pollicis	Normal.	Normal.	Normal.	Normal.
Flexor digitorum sublimis	Three tendons.	Same.	Same.	Four tendons.
Flexor digitorum profundus	Three heads.	Four heads.	Heads are indistinct.	Four heads.
Flexor carpi radialis	Normal.	Normal.	Normal.	Normal.
Palmaris longus	Normal.	Smaller.	Absent.	Larger.
Pronator quadratus	Normal.	Normal.	Attached to proximal half of forearm.	Larger.
Flexor carpi ulnaris	Normal.	Normal.	Portion is inserted upon styliform cartilage.	Normal.
Biceps brachii	Normal.	Insertion is mostly upon radius.	As in arboreal squirrel.	Insertion wider only upon radius.
Brachialis	Normal.	Insertion is posterior to insertion of biceps.	As in arboreal squirrel.	Normal.
Supinator	Normal.	Normal.	Normal.	Inserted over wider area.
Supinator longus	Absent.	Normal.	Larger.	Normal.
Clavobrachialis	Absent.	Absent.	Absent.	Present and normal.

Muscle.	Rat.	Arboreal squirrel.	Flying squirrel.	Prairie dog.
Triceps longus	Normal.	Normal.	Normal.	Normal.
Triceps lateralis	Normal.	Also originates from fascia.	Normal.	Normal.
Triceps medialis	Normal.	Normal.	Normal.	Normal.
Anconeus lateralis	Normal.	Normal.	Normal.	Normal.
Epitrochlearis	Normal.	Wider.	Widest.	Normal.
Doris epitrochlearis	Absent.	Absent.	Found along posterior margin of epitrochlearis.	Absent.
Clavotrapesius	Normal.	Fused to acromio-trapezius.	As in the arboreal squirrel.	Normal.
Acromiotrapesius	Normal.	Fused to acromiotrapezius and spinotrapezius.	As in the arboreal squirrel.	Normal.
Spinotrapezius	Normal.	Fused to acromiotrapezius.	As in the arboreal squirrel.	Normal.
Spinodeltoid	Normal.	Normal.	Originates from ventral three fourths of scapula.	Normal.
Acromiodeltoid	Normal.	Normal.	Portion originates from clavicle.	Normal.
Clavodeltoid	Normal.	Normal.	Normal.	Two parts.
Infraspinatus	Normal.	Normal.	Normal.	Normal.
Supraspinatus	Normal.	Normal.	Normal.	Normal.
Teres minor	Normal.	Normal.	Normal.	Normal.
Teres major	Normal.	Normal.	Normal.	Normal.
Subscapularis	Normal.	Divided by the spinous ridge of the scapula.	As in the arboreal squirrel.	Normal.
Latissimus dorsi	Normal.	Origin is broader.	Origin is broader, partially fused with spinotrapezius.	Origin is broader, inserted by two slips.
Panniculus carnosus	Heaviest.	Smaller.	Smallest.	Smaller.
Sternomastoid	Normal.	Normal.	Broader.	Normal.
Serratus magnus	Arises from thoracic ribs 3, 4, 5 and 6.	Arises from thoracic ribs 4, 5, 6, 7 and 8.	As in the arboreal squirrel.	As in the arboreal squirrel.

Muscle.	Rat.	Arboreal squirrel.	Flying squirrel.	Prairie dog.
Levator scapulae	Arises from transverse processes of cervical vertebrae from 2 to 7 and from thoracic ribs 1 and 2.	Arises from transverse processes of cervical processes 6 and 7 from first 3 thoracic vertebrae.	As in the arboreal squirrel.	As in the arboreal squirrel.
Rhomboideus anticus	Normal.	Normal.	Normal.	Normal.
Rhomboideus posticus	Normal.	Normal.	Normal.	Normal.
Rhomboideus profundus	Absent.	Not very distinct from occipitoscapularis.	Attached from head to spine of scapula.	As in the arboreal squirrel.
Occipitoscapularia	Normal.	Normal.	Normal.	Wider.
Atlantoscapularis	Normal.	Fused to clavotrapesius at origin.	Normal.	Normal.
Pectoralis superficialis	Normal.	Normal.	Insertion is distad to clavodeltoid.	More distinct.
Pectoralis profundus anterior	Normal.	Normal.	Broader insertion.	Normal.
Pectoralis profundus posterior	Normal.	No connection with clavicle.	Consists of two portions.	Normal.
Pectoralis	Normal.	No corocoid attachment.	Arises mostly from the sixth sternebrae.	Normal.
Cleidomastoid	Normal.	Area of origin broader.	As in arboreal squirrel.	As in arboreal squirrel.
Omohyoid	Normal.	Normal.	Portion inserted upon metacromoin process.	Normal.
Subclavius	Normal.	Better developed.	Larger.	Larger.
Platysma	Dorsal origin from occiput to interscapular fossa.	As in rat.	Dorsal origin from occiput to fourth cervical vertebrae, additional slip passes from cheek to pollex.	Scapular portion much heavier.
Interscutularis	Normal.	Normal.	Normal.	Normal.
Orbicularis oris	Normal.	Normal.	Normal.	Normal.

Muscle.	Rat.	Arboreal squirrel.	Flying squirrel.	Prairie dog.
Levator labii	Normal.	Normal.	Normal.	Normal.
Buccinatorius	Large.	Smaller.	Smaller.	Smaller.
Dilator naris	Normal.	Normal.	Normal.	Normal.
Auriculo labialis	Normal.	Normal.	Normal.	Normal.
Sternofascialis	Normal.	Normal.	Absent.	Normal.
Caudo accessorius	Absent.	Absent.	Extends from tail to gastrocnemius.	Absent.
Rectus abdominis	Decussates at origin.	No decussation.	No decussation.	No decussation.
Obliquus abdominis externus	Origin from last nine ribs.	Larger.	Normal.	Origin from last ten ribs.
Obliquus abdominis internus	Normal.	Normal.	Normal.	Normal.
Transversalis	Normal.	Normal.	Normal.	Normal.
Spinalis dorsi	Normal.	Normal.	Normal.	Normal.
Longissimus dorsi	Normal.	More tendinous.	More tendinous.	Normal.
Iliocostalis	Normal.	Fused to longissimus dorsi at level of ninth rib.	Fused to longissimus dorsi posterior to the ribs.	Normal.
Mulifidus spinae	Normal.	Normal.	Normal.	Normal.
Intertransversarii	Normal.	Normal.	Normal.	Normal.
Interspinalis	Normal.	Normal.	Normal.	Normal.
Quadratus lumborum	Normal.	Normal.	Normal.	Normal.
Psoas minor	Absent.	Origin is from second to fifth lumbar vertebrae.	Origin is from second to fourth lumbar vertebrae.	Same as flying squirrel.
Splenius	Origin begins from first thoracic spine.	Origin begins from fourth thoracic spine.	Origin begins from fifth thoracic spine,	Origin begins from third thoracic spine.

Muscle.	Rat.	Arboreal squirrel.	Flying squirrel.	Prairie dog.
Biventer Cervices	Normal.	Normal.	Originates from third and fourth ribs.	Normal.
Complexus	Normal.	Normal.	Originates from the first four thoracic and last five cervical vertebrae.	Originates from the first three thoracic and last five cervical vertebrae.
Rectus capitis posterior major	Normal.	Normal.	Normal.	Normal.
Rectus capitis posterior minor	Normal.	Normal.	Normal.	Normal.
Rectus capitis lateralis	Normal.	Normal.	Normal.	Normal.
Obliquus capitis inferior	Normal.	Normal.	Normal.	Normal.
Longus atlantis	Normal.	Normal.	Normal.	Normal.
Semispinalis cervicis	Normal.	Normal.	Normal.	Normal.
Longissimus capitis	Normal.	Normal.	Normal.	Normal.
Scalene	Consists of three heads.	Ventral head absent.	Same as in the rat except ventral head consists of only one part.	Ventral head absent.
Longus capitis	Normal.	Normal.	Normal.	Normal.
Longus colli	Originates from second to sixth thoracic vertebrae.	Originates from second to fifth thoracic vertebrae.	Same as arboreal squirrel.	Bundles are more tendinous.
Masseter	Portion of masseter major passes through infra orbital foramen.	Does not pass through infra-orbital foramen.	Same as in arboreal squirrel.	The superficial head has a more extensive origin. Otherwise as in squirrels.
Temporalis	With difficulty separated into two parts.	Less difficult to separate.	Less difficult to separate.	Easily separated.
Pterygoideus externus	Normal.	Normal.	Normal.	Normal.
Pterygoideus internus	Normal.	Origin more extensive.	Normal.	Origin more extensive.
Digastricus	Normal.	Normal.	Normal.	Tendon joining the two bellies is longer.

Muscle.	Rat.	Arboreal squirrel.	Flying squirrel.	Prairie dog.
Transversus mandibularis	Normal.	Normal.	Normal.	More extensive.
Sternohoideus	Normal.	Normal.	Normal.	Normal.
Sternothyroideus	Normal.	Normal.	Normal.	Normal.
Thyrohyoideus	Normal.	Normal.	Normal.	Normal.
Stylohyoideus	Normal.	Normal.	Normal.	Normal.
Mylohyoideus	Normal.	Normal.	Normal.	Normal.
Genioglossus	Normal.	Normal.	Normal.	Normal.
Styloglossus	Normal.	Normal.	Normal.	Normal.
Hyoglossus	Normal.	Normal.	Normal.	Normal.
Serratus posterior superior	Originates from ribs four to seven, inserted from fourth cervical to first thoracic vertebra.	Originates from ribs fourth to nine, insertion is from fourth cervical to sixth vertebrae.	As in rat.	As in arboreal squirrel.
Serratus posterior inferior	Normal.	Anterior portion overlaps the posterior slip of serratus posterior superior.	Normal.	Same as in arboreal squirrel.
Sternocostalis	Normal.	Normal.	Normal.	Normal.
Intercostalis externi	Normal.	Normal.	Normal.	Normal.
Intercostalis interni	Normal.	Normal.	Normal.	Normal.
Extensor caudae medalis	Normal.	Less tendinous.	Less tendinous.	Less tendinous.
Extensor caudae lateralis	Normal.	Less tendinous.	Less tendinous.	Less tendinous.
Flexor caudae longus	Normal.	Less tendinous.	Less tendinous.	Less tendinous.
Flexor caudae brevis	Normal.	Less tendinous.	Less tendinous.	Less tendinous.
Abductor caudae internus	Normal.	Less tendinous.	Less tendinous.	Less tendinous.

Muscle.	Rat.	Arboreal squirrel.	Flying squirrel.	Prairie dog.
Abductor caudae externus	Normal.	Less tendinous.	Less tendinous.	Less tendinous.
Iliacus	Normal.	Normal.	Normal.	Normal.
Psoas magnus	Normal.	Normal.	Normal.	Normal.
Gluteus superficialis	Normal.	Aponeurosis of insertion more extensive in anterior part. Posterior part begins origin from Poupart's ligament.	Normal.	Same as in arboreal squirrel.
Gluteus maximus	Normal.	Normal.	Normal.	Normal.
Gluteus medius	Normal.	Normal.	Normal.	Normal.
Gluteus minimus	Normal.	Normal.	Normal.	Normal.
Pyriformis	Normal.	Normal.	Normal.	Normal.
Gemellus superior	Normal.	Normal.	Normal.	Normal.
Gemellus inferior	Normal.	Normal.	Normal.	Normal.
Obturator internus	Normal.	Normal.	Normal.	Normal.
Obturator externus	Normal.	Normal.	Normal.	Normal.
Quadratus femoris	Normal.	Normal.	Normal.	Normal.
Biceps femoris anticus	Normal.	Origin from dispophyses of first and second caudal vertebrae. Insertion upon lateral sesamoid and distal end of femur.	Same as in arboreal squirrel.	Same as in arboreal squirrel.
Biceps femoris posticus	Normal.	Insertion is upon upper two thirds of the tibia.	Insertion is upon upper one half of the tibia.	Normal.
Tenuissimus	Usually absent.	Larger.	Larger.	Larger.
Semitendinous	Normal.	Normal.	Normal.	Normal.

Muscle.	Rat.	Arboreal squirrel.	Flying squirrel.	Prairie dog.
Semimembranous anticus	Normal.	Origin from upper portion of the lateral surface of the ischium. Superficial portion is inserted upon lower posterior and lateral border of the femur.	Normal.	Normal.
Semimembranous posticus	Normal.	Normal.	Normal.	Normal.
Rectus femoris	Normal.	Normal.	Normal.	Normal.
Vastus lateralis	Normal.	Normal.	Normal.	Normal.
Vastus medalis	Normal.	Normal.	Normal.	Normal.
Vastus femoris	Normal.	Normal.	Normal.	Normal.
Gracilis	One head.	Two heads.	Same.	Two heads.
Adductor longus	Normal.	Smaller and cylindrical in shape. Inserted by longest tendon.	As in arboreal squirrel.	As in arboreal squirrel.
Adductor brevis	Normal.	Normal.	Normal.	Normal.
Adductor magnus	One part.	Three parts.	Three parts.	Three parts.
Pectineus	Normal.	Area of insertion smaller.	As in arboreal squirrel.	As in arboreal squirrel.
Popliteus	Normal.	Normal.	Normal.	Normal.
Gastrocnemius medialis	Normal.	Normal.	Normal.	Normal.
Gastrocnemius lateralis	Normal.	Normal.	Normal.	Normal.
Plantaris	Normal.	Not attached to gastrocnemius lateralis.	As in arboreal squirrel.	As in arboreal squirrel.
Soleus	Normal.	Normal.	Normal.	Normal.
Tibialis posticus	Normal.	Normal.	Normal.	Normal.

Muscle.	Rat.	Arboreal squirrel.	Flying squirrel.	Prairie dog.
Flexor	Slip passes to sole.	Slip passes to sole, but another passes to tendon of extensor hallucis.	As in arboreal squirrel.	As in arboreal squirrel.
Flexor digitorum fibularis	Normal.	Normal.	Normal.	Normal.
Tibialis anticus	Normal.	Normal.	Normal.	Normal.
Extensor hallucis	One slip.	Two slips.	Two slips.	Two slips.
Extensor digitorum longus	Normal.	Normal.	Normal.	Normal.
Peroneus longus	Normal.	Normal.	Normal.	Normal.
Peroneus brevis	Normal.	Normal.	Normal.	Normal.
Peroneus digiti quarti	Normal.	Normal.	Normal.	Normal.
Peroneus digiti quinti	Normal.	Normal.	Normal.	Normal.
Extensor digitorum brevis	Normal.	Normal.	Normal.	Normal.
Flexor digitorum brevis	Normal.	Fleshy portion absent.	Fleshy portion absent.	Fleshy portion absent.
Abductor digiti quinti	Normal.	Normal.	Normal.	Normal.
Quadratus plantae	Normal.	Normal.	Normal.	Normal.
Lumbricales	Normal.	Normal.	Normal.	Normal.
Interossei of foot	Normal.	Normal.	Normal.	Normal.

SUMMARY

Of Osteological Differences in the Forms Studied, Pertaining Only to Adaptational Causes

	Rat.	Arboreal squirrel.	Flying squirrel.	Prairie dog.
Thoracic ribs: Number	13	12	12	12
Thoracic basket	Normal.	Normal.	Somewhat flattened.	More rounded.
Sternum: Manubrium	Normal.	Normal.	Broader.	Normal.
Scapula:				
Corocoid process	Normal.	Longer.	Longer.	Longer.
Acromion process	Normal.	Larger.	Normal.	Larger.
Metacromion process	Small.	Larger.	Larger.	Largest.
Medial spine	Absent.	Present.	Present.	Small.
Clavicle: Length	Normal.	Longer.	Longest.	Longer.
Pelvis:				
Angle of ilium to sacrum	0 degree.	19 degrees.	17 degrees.	25 degrees.
Angle of pelvis to sacrum	0 degree.	Greater than flying squirrel.	Greater than rat.	Greatest.
Superficial tuberosities	Normal.	Well developed.	Little developed.	Best developed.
Femur: Average percent of femur length to hind limb	32.1	32.6	37.7	32.3
Tibia and Fibula: Average percent to length of hind limb	33.9	34.1	38.0	33.1
Foot: Average percent to length of hind limb	33.9	33.1	27.1	35.9

	Rat.	Arboreal squirrel.	Flying squirrel.
Humerus:			
Deltoid ridge	Largest.	Smaller.	Smaller.
Length	Normal.	Longer.	Longest.
Ulna:			
Average percent of length of olecranon to ulna	12.2	13.7	6.0
Length	Normal.	Longer.	Longest but weakest.
Radius:			
Styloid process	Normal.	Broader.	Normal.
Articular circumference	Flattened oval.	Oval.	Oval.
Skull:			
Cheek teeth	Presence of six or seven cusps.	Four cusps.	Four cusps.
Incisors	Strong.	Same.	Same.
Zygomatic arch	Normal.	Normal.	Normal.
Crests	Normal.	Normal.	Normal.
Coronoid process	Normal.	Normal.	Normal.
Angular process	Normal.	Larger.	Normal.
Cervical vertebrae:			
Zygopophyses	Reduced.	Larger.	Larger.
Spine of atlas	Normal.	Normal.	Normal.
Ventral process of sixth vertebrae	Longest.	Very short but area is enlarged.	As in arboreal squirrel.
Average percent to vertebral body length	14.6	13.0	12.8

Prairie dog:
Larger. Shorter.
17.3 Shorter.
Broadest. Same.
Four cusps. Three external ones modified as crests. Larger grinding surface. Additional upper premolar. Weaker. Much broader and more curved. More prominent. Larger.
Largest and turned inward.
Larger. Larger. As in arboreal squirrel. 13.1

	Rat.	Arboreal squirrel.	Flying squirrel.	Prairie dog.
Thoracic vertebrae:				
Number	13	12	12	12
Average length of second spine	8 mm.	9 mm.	2 mm.	11 mm.
Remaining spines	Uniform in length and about 5 mm. in length.	Decrease in length posteriorly.	Same as arboreal squirrel.	Same as arboreal squirrel.
Lumbar vertebrae:				
Number	6	7	7	7
Diapophyses	Normal.	Longest.	Shorter.	Longer.
Spines	Normal.	Longest.	Shorter.	Shorter and broader.
Posterior zygopophyses	Normal.	Slightly upturned.	Normal.	Normal.
Sacral vertebrae:				
Number	4 and occasionally 3.	3 and occasionally 4.	Same as arboreal squirrel.	Same as arboreal squirrel.
Length as compared to vertebral body length	Longest.	Shorter.	Shorter.	Shorter.
Caudal vertebrae:				
Number	Average 28.	Average 26.	Average 23.	Average 13.
Average percent of tail to total length	54.6	40.4	58.3	26.3
Diapophyses	Small and curved anteriorly.	Large and directed lateral.	Same as in arboreal squirrel.	Same as in arboreal squirrel.
Chevron bones	Small and incomplete.	Large and complete.	Large and complete.	Larger than in rat.

	Rat.	Arboreal squirrel.	Flying squirrel.	Prairie dog.
Carpus:				
Average length of pisiform	2 mm.	4 mm.	2.5 mm.	4 mm.
Styliform process	Absent.	Absent.	Present.	Absent.
Falciform	Normal.	Normal.	Normal.	Much larger.
Metacarpals	Longest.	Intermediate.	Intermediate.	Shortest.
Digits—Average length:				
Number 2	17 mm.	35 mm.	15 mm.	32 mm.
Number 3	20 mm.	40 mm.	17 mm.	36 mm.
Number 4	18 mm.	43 mm.	17 mm.	31 mm.
Number 5	14 mm.	35 mm.	15 mm.	24 mm.
Claws	Recurved and sharp.	Same.	Same.	Elongated, dull and slightly recurved.

GENERAL SUMMARY

Finger Action

Finger action is best developed in squirrels and rats, as evidenced by smooth, round tendons, distinct musculature, less fascia, and full complement of muscles.

Burrowing

The prairie dog is the best burrower, as shown by the elongated claws, great development of flexors of thoracic limb, stronger neck muscles, sacrifice of speed for force by elongation of olecranon process and pisiform bone and short tail.

Climbing

Climbing is best developed in the arboreal squirrel, with the flying squirrel next. This is shown by elongation of digits and limbs, rudimentary pollex, best development of extensors of digits and flexors of forearm, best development of hind limb musculature in arboreal squirrel, well-developed trapezius group of muscles, narrow body, strong clavicles, and long diapophyses.

Jumping

This adaptation is best developed in the arboreal squirrel. It is evidenced by the very strong hind-legs, well-developed abdominal and back musculature, and long bushy tail.

Running

This adaptation is best seen in the rat and arboreal squirrel. In the latter, structures which are an aid in climbing and jumping are also useful in running. These are shown by the well-muscled and elongated legs, short olecranon process, strong back and abdominal musculature, and large angle of extension between humerus and forearm. In addition to these structures, the metacarpals are relatively the longest in the rat, while the ilia are not curved laterally.

Sitting

Sitting is best developed in the prairie dog, with the arboreal squirrel and flying squirrel following in order. It is represented by the angle of the upper border of the ischium to the sacrum, by the angle of the medial border of the ilium to the sacrum, and by the ischial tuberosities.

Gliding

Strictly speaking, gliding is present only in the flying squirrel. It is shown by presence of wing membranes, flattened body, flattened and thickly haired tail, well-developed forearm flexors, well-developed adductors of upper arm, and greatly elongated limbs.

Mastication

The musculature of mastication is best developed in the prairie dog, as shown by the greater grinding surface and crest formation. It is next best developed in squirrels, due to gnawing habits.

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Some Factors in the Morphogenesis of Embryonic Epithelia[1]

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An early embryonic epithelium maintains itself as an epithelium by the formation of terminal bars. In most cases terminal bars originate from spindle fibers, as described by Schneider,[2] and may appear as a homogeneous line, a row of dots, a ribbon with projections, or as a double structure. The attachment of the cells to each other by terminal bars makes the cells draw to the free surface as an accompaniment of the rounding up in mitosis. The elongation of the cells after division determines the thickness and surface area of a columnar epithelium. This elongation usually cannot be attributed to crowding from without, but is due to cytoplasmic forces, which may be associated with the persistence of spindle fibers and the elongation of these fibers to produce such cytoplasmic fibers as those described for the gut of the garter snake.[3] A specialized part of the network of fixed cytoplasm, the terminal web, covers the free surface of the cell and limits its area. Disappearance of the terminal web in mitosis is correlated with an extension of the cell end.

Trans. Kansas Acad. Sci. 39, 1936.

1. Abstracted from notes of the author by Mary Elmore Sauer (Mrs. F. C. Sauer).

2. Schneider, Karl: "Lehrbuch der vergleichenden Histologie der Tiere," Jena, 1902. pp. 116-117. "Histologisches Praktikum der Tiere," Gustav Fischer, Jean, 1908, pp. 28-32.

3. Sauer, F. C.: The interkinetic migration of embryonic epithelial nuclei, Journal of Morphology, in press.

Notes and Comments on Certain American and Mexican Snakes of the Genus Tantilla, with Descriptions of New Species.

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A revision of the genus *Tantilla*, although needed beyond peradventure, must await the segregation of a far greater number of specimens than are now available in the museums of the world. In 1896 Boulenger recognized 23 species in the total of 44 forms that had received names. Since the publication of the third volume of Boulenger's Catalogue, the total number of names has risen to something more than 50.

In genera whose species are subterranean for the most part, and in consequence tend to wander less, there is a tendency to develop a greater number of species than in more vagrant terrestrial genera. This seems to be true of *Tantilla*, and with sufficient specimens from type and other localities, numerous forms not already rescued from Boulenger's synonymies will of necessity be restored and given proper recognition.

The *Tantilla* material available at Kansas consists of 154 specimens, referable to 10 species, 3 of which are recognized as new forms. One of the most surprising results of the study is the recognition of a species in Oklahoma and New Mexico, identical with (or closely related to) the species described by Günther as *Homalocranium atriceps* from Nuevo León, Mexico. Four specimens studied have been referred to this species. It seems highly probable that an examination of other collections will reveal specimens of this species masquerading under some other catalogue designation.

Doctor Charles Burt has recently relegated *T. nigriceps* to a subspecific status under *T. gracilis* without showing that such a relationship exists. It is not improbable that he has mistaken *atriceps* as being an intergrade between *nigriceps* and *gracilis*. The specimens available to me, from counties in Kansas from which both *nigriceps* and *gracilis* are known to occur (Riley, Cowley, Geary), as well as in Texas, show no tendency whatever toward intergradation of characters which are pertinent in separating the species. Moreover, I consider the possibility quite remote that any such intergradation takes place.

Tantilla coronata Baird and Girard

Tantilla coronata Baird and Girard, Cat. North Amer. Rept., pt. I, 1853, p. 131 (type description; type locality, Kemper county, Miss.).

Four specimens of this species have been examined, two (K. U. Nos. 2472a, 2472b) from Perryville, Decatur Co., Tenn., E. H. Taylor Coll.; and two (K. U. Nos. 19582-83) from Cedar Springs Valley, Edmonson Co., Ky., Claude Hibbard Coll. These specimens present the following characters:

No.	*Sex*	*Ventrals*	*Caudals*	*Upper Labials*	*Lower Labials*	*Pre-oculars*	*Post-oculars.*
2472a	f.	140	45	7-7	6-6	1-1	2-2
1472b	f.	143	43	7-7	6-6	1-1	2-2
19582	m.	133	44	6-6	4-6	1-1	2-2
19583	f.	141	41	7-7	6-6	1-1	2-2

The total length and tail measurements (in millimeters) of these four specimens are respectively: 248, 47; 242, 43.5; 226, 43; 242, 42.

Tantilla bocourti Günther

1883. *Homalocranium coronatum* (*non* Baird and Girard) Bocourt, Mission Scientifique au Mexique et dans l'Amerique Central, Liv. 9, 1883, pp. 589-590; and 1886, Liv. 10, pl. xxxvii, figs. 5. 5a-d.

1895. *Homalocranium bocourti* Günther, Biologia Centrali-Americana, Reptilia and Batrachia, 1895, p. 149.

1928. *Tantilla bocourti* Dunn, Amer. Mus. Nov., No. 314, May 16, 1928, p. 2.

Four specimens of this species are in the Mexican collection. Three were collected by Hobart M. Smith, near Magdalena, Jalisco (No. 4552, June 11, 1935; 4553, June 28, 1935; 4554, June 29, 1935). The fourth (4551), I collected two miles east of Acultzingo, Vera Cruz, July 27, 1932.

The following table shows the principal characters and variations observable in the four specimens (measurements in millimeters).

No.	*Sex*	*Length*	*Tail*	*Width head*	*Length head*	*Frontal*	*Greatest supraocular width*
4552	f.	227	48	4.3	5.9	2.4 × 1.8	1
4553	f.	259	55	4.6	6.4	2.5 × 1.6	1.1
4554	f.	124	22.3	3.2	4.6	2.1 × 1.5	.8
4551	f.	301	58	6.6	7.8	3 × 2	1.3

No.	*Ventrals*	*Sub-caudals*	*Pre-oculars*	*Post-oculars*	*Upper labials*	*Lower labials*	*Scale formula*
4552	175	59	1-1	2-2	7-7	6-6	15-15-15
4553	177	61	1-1	2-2	7-7	6-6	15-15-15
4554	169	56	1-1	2-2	7-7	6-6	15-15-15
4551	170	51	1-1	2-2	7-7	6-6	15-15-15

In all the specimens the anal is divided, the posterior nasal touches the preocular, the temporals are 1-1; in two, the mental touches the first chinshields; in two, the first labials are in contact behind the mental.

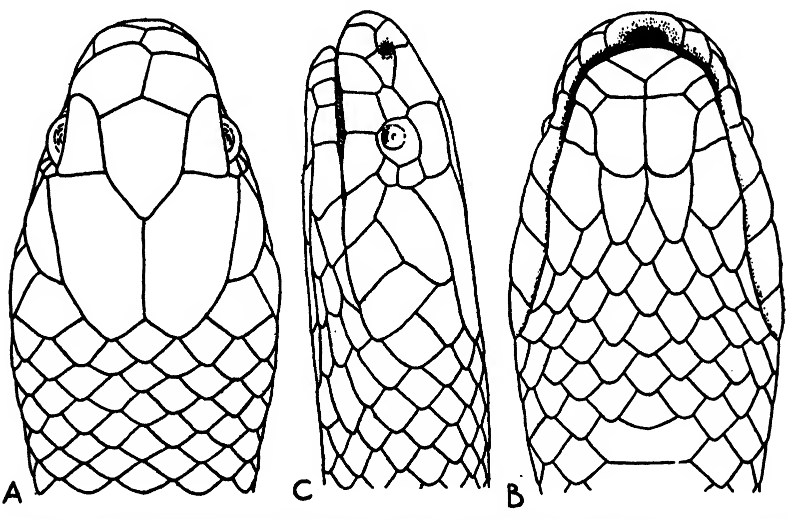

FIG. 1. *Tantilla bocourti* Günther E. H. T. No. 4551. Width of head, 6.6 mm. Dorsal view (A), lateral view (C), and ventral view (B), of head.

The collars are as follows: two scale rows white, one and one half black; one and one half white, one and three quarters black; one and one third

white, one black; in the specimen from Acultzingo, there are two white and two black scale rows.

The type specimens described by Bocourt measure 245 mm., 245 mm.; tails 49 mm., 50 mm.; the ventrals are 172, 176; and 55, 55 for the subcaudals. The white collar is about one and one half scale rows wide, and the black collar following, about one row wide. There is a light spot on the anterior part of the supraocular.

On my largest specimen there are two light spots on the anterior ends of the parietals; in No. 4552 the outer of the two is not wholly separated from the white area on the labials (inner spot absent on one side). Two of the specimens, Nos. 4553, 4551 (as is true of *T. deviatrix*), have the median part of the black semicollar extending forward medially, partially interrupting the white (yellowish) collar.

Dunn has described a specimen from Distrito Federal, having a ventral count of 195, and a subcaudal count of 57. This count seems to be extraordinarily high.

Tantilla gracilis Baird and Girard

1853. *Tantilla gracilis* Baird and Girard, Catalogue North Amer. Reptiles, pt. 1, Serpents, Jan. 1853. p. 132 (type description; type locality, Indianola, Texas; Col. J. D. Graham, Coll.).

1860. *Tantilla Hallowelli* Cope, Proc. Acad Nat. Sci. Philadelphia, Feb. 1860, p. 77 (type description by reference to a description of a Kansas specimen described by Hallowell as *Tantilla gracilis*, Proc. Acad. Nat. Sci. Phila., 6:246. 1857. p. 246).

1934. *Tantilla gracilis gracilis* Burt, Amer. Midland Nat., 16:336. 1934.

This small species ranges from eastern Kansas and central Missouri south to the Gulf through Arkansas, Oklahoma, central and western Texas, overlapping in part territory occupied by *Tantilla nigriceps* and *T. atriceps*.

I have examined in the collection at Kansas, 124 specimens of this species from the following localities:

Kansas records: *Riley Co.:* (E. H. Taylor 4) (Herpetology Class 2); *Leavenworth Co.:* 4 miles north of Lawrence (W. H. Burt 15); *Douglas Co.:* near Lawrence (E. H. Taylor 7) (C. D. Bunker 1) (E. H. Taylor and Paul Woolley 11) (C. H. Martin 4) (L. Coghill 2) (Claude Hibbard and E. H. Taylor 2) (T. White 1) (Lloyd Youse 1) (R. H. Beamer 5) (W. Whitlow 1); *Chase Co.:* Cottonwood Falls (H. Smith, C. Hibbard and A. B. Leonard 6); *Anderson Co.:* Cedar Creek near Garnett (E. H. Taylor and David Dunkle 20) (E. H. Taylor 3) (Herpetology class 5); *Greenwood Co.:* (Tihen and Willy 14); *Sumner Co.:* (E. H. Taylor 1); *Cherokee Co.:* Near Baxter Springs (E. H. Taylor 2); *Montgomery Co.:* Sycamore Hill (T. White 1) (E. H. Taylor 1) (E. H. Taylor and W. McKnown 2).

Oklahoma records: *Payne Co.:* Stillwater (B. Brown 1); Drumright (Mildred Parker 2).

Texas records: *Bexar Co.:* (A. J. Kirn 1); *Frio Co.:* (E. H. Taylor and J. S. Wright 1); *Atascosa Co.:* Benton (E. H. Taylor and A. J. Kirn 3); *McLennan Co.:* Waco (E. H. Taylor 5); *Dallis Co.:* Dallas (C. E. Burt 1) *Brewster Co.:* Near Glen Springs (E. H. Taylor 1).

The ventral count of the Kansas specimens varies between 116 and 134; specimens whose scale count falls within the lower ten (116 to 125) are usually males; those with counts from 124 to 134 are usually females. The subcaudals vary between 38 and 53, the lower nine counts are usually from

females, the upper nine are usually from males. The totals of the ventrals and subcaudals vary between 162 and 179 or a variation of 18 scales in the totals. In the north-south range the higher counts are usually indicative of females.

In the Texas specimens the average is slightly lower, the range being from 111 to 132, subcaudals 41-50 (12 specimens). In the 124 specimens, 20 showed some variation in the labial counts and of these 11 were from the same hillside in Leavenworth Co., Kansas. The normal count of labials is 6-6 upper and 6-6 lower. The variations are, 7-8, three specimens; 7-7, four; 6-8, four; 6-7, nine. Where eight scales occur the second or third and the fifth are divided; in the case of seven scales, the fifth, the second or the third are split, one about as frequently as the other. One specimen having a formula 6-6 has the fourth and fifth fused, while the second is divided.

Since seven is the typical generic number of labials, it is not surprising that the fifth should occasionally divide, thus making a total of seven in *gracilis*. Since the number seven is typical of *Tantilla nigriceps* one might mistakenly regard this as evidence of mixture with that form. I believe this far from the case, for in every instance where the labial formula resembled that of *nigriceps,* in all other features the species remained unchanged. Two specimens were discovered each having two postoculars on one side each. This condition, too, may be regarded as typical of the genus and not surprising that it occurs occasionally in *gracilis*. Here, again, there was no approach to characters of *nigriceps*. In one specimen the prefrontals are fused with the preocular.

The relation of the mental to the first pair of chinshields is variable. The latter are usually in contact but in probably ten percent of the specimens the scales are separated by the union of the first labials.

The first temporal is frequently excluded from contact with the postocular by the intervention of the parietal and fifth labial; likewise the nasal is separated from the preocular by the intervention of the prefrontal, which is in contact with the upper labials.

In none of the 124 specimens is there any approach to the typical dorsal head markings, terminating in a median angle (which is characteristic of *nigriceps*) posterior to the parietals; nowhere is there an overlapping of total scale count of *nigriceps* with those of *gracilis* in Kansas specimens. A single specimen of *nigriceps* from Atascosa Co., Texas, with a total count of 176 scales, is within the range of some of the northern specimens of *gracilis*; in all northern specimens there is a hiatus of from 4 to 28 scales between the two scale ranges.

As regards size, *nigriceps* is a very much larger snake, the four largest specimens of the 13 examined reaching 273, 292, 320, 347 mm.; while the three largest specimens of *gracilis* were 220, 230, 260.

The color of the head of *gracilis* varies from a shade scarcely darker than the body, to one that is quite dark. There is in all, however, a deposition of more pigment on the head than on the body, forming or tending to form a somewhat characteristic pattern. The lateral edges of the dark area of the head reach halfway down on the anterior labials, passing below the eye, around which the color is nearly black, then turn up somewhat, leaving the fifth labial, part of the temporal and the anterior part of the sixth labial im-

maculate; on the scales behind the temporals and last labial this color extends over four or five scales, thus extending the dark color back farther on each side than medially—the reverse of the condition in *nigriceps*. The color does not reach the lower labials.

Tantilla atriceps (Günther)

1895. *Homalocranium atriceps* Günther, Biologia Centrali-Americana, Rept., 1895, p. 146 pl. LII, dorsal, ventral and lateral views of head. (Type description. Type locality, Nuevo León, Mexico. W. Taylor, collector. Types, two males. British Museum); Boulenger, Cat. Snakes British Museum, 3:226. 1892.

This species is described from two male specimens from Nuevo León, Mexico. I am referring four specimens to this species.

A specimen (No. 4555) which I collected four miles west of Saltillo, Coahuila, Mexico, August 23, 1932, presents the following characters: Diameter of eye equal to about one third the length of the snout; the part of the rostral visible above equal to about one half the distance from rostral to frontal; internasal slightly more than a half of the prefrontals; frontal hexagonal, the anterior angle very obtuse, the posterior acute, one and a third to one and a half times as long as broad. The frontal is very nearly thrice as wide as the supraocular, and a little longer than its distance to the end of the snout; parietal a little longer than its distance from the end of the snout and about the width of the frontal; nasal divided or certainly partially divided, the posterior moiety not in contact with the preocular; *one postocular*; upper labials 7-7; temporals 1-1, both narrow; lower labials 6-6; two pairs of chinshields, the anterior much larger than posterior; four pairs of scales, and one fused pair, between the posterior chinshields and the first wide ventral; mental very minutely in contact with the chinshields; four lower labials touch first chinshield. Ventrals 130; anal divided; subcaudals 66. Labials, order of size: 1, 2, 3, 6, 4, 5, 7; scale formula 15-15-15. Total length 178 mm; tail 56 mm.; tail length as percent of body 31. Width of head 3 mm.; length of head (to end of parietals) 5.2 mm.

Color. Slightly brownish gray, somewhat pinkish white below; head slate-black, somewhat lighter anteriorly, the dark color involving posteriorly one row of scales behind the parietals, this bordered by a narrow, dim yellowish line apparently not reaching down on sides of neck to ventrals.

From the types, there are two points of difference worthy of mention. The types have the mental separated from the chinshields and there are two postoculars. The former character one might expect to vary, but the fusion of the two postoculars is a rare anomaly in the genus. I do not see fit to regard this as warranting separation from *atriceps* unless series of specimens should prove constantly different from *atriceps*, a possibility which I consider unlikely.

A small specimen which I collected at Washington Camp, two miles south of Carlsbad Cavern, Eddy Co., New Mexico, and two specimens collected by Mildred Parker at Drumright, Okla., are likewise referred to this species.

The Carlsbad specimen (K. U. 16120) agrees very well with the type description of *atriceps*. The ventrals are 138, subcaudals 57. It is a young female. The proportion of tail to body is 23.1%. The labials are 7-6, the fifth and sixth abnormally fused on side; preoculars 1-1, postoculars 2-2. The labial order is 1, 2, 3, 6, 5, 4, 7, on the normal side. There is considerable pigment on the underside of head. In two specimens from Drumright, Okla. (K. U.

Nos. 16414, 16415), the labials are normally 7-7 upper, 6-6 lower in each; the ventrals 143-147, and the subcaudals 56 and 60, respectively; the measurements of the first specimen are, 230 mm. total length, tail 61 mm., percentage of tail to body 26.5; of the second, total length 211, tail 52 mm., the percentage 23.7. The labial order of size is 1, 2, 3, 6, 5, 4, 7. In each the color is that of the type of *atriceps;* the whitish or yellowish collar is no more distinct than that shown in the figure of the type.

Tantilla eiseni Stejneger

1895. *Tantilla eiseni* Stejneger, Proc. U. S.. Nat. Mus., 18:117-118. 1895. (Type description. Type locality, San Joaquin Valley, California. Type 11766a, U. S. Mus., Dr. G. Eisen, Coll.)

One specimen (K. U. 6664) from Lyon's Valley, San Diego Co., Cal., collected by L. M. Klauber, presents the following characters: Ventrals 164; Subcaudals, 68; upper labials, 7-7; lower labials 6-6 (in the type, 7-7); preoculars, 1-1; postoculars 2-2; mental in contact with first chinshields; eye about one third of the length of the snout; internasals less than half the prefrontals. Black of head extends on first two scale rows following the parietals; the black extends laterally to the scales behind the last lower labials; white area on labials begins on anterior part of the last upper labial and extends forward to rostral, involving practically all of the fifth labial and the lower two thirds of the others; the light brown pigment on the dorsal scales is extended to the outer scale row.

Length 346 mm., tail 63. Proportion of tail to body length 25.6 percent.

Tantilla hobartsmithi, sp. nov.

Holotype. No. 4558. Collected near La Posa, 10 mi. northwest of Guaymas the night of July 3, 1934. E. H. Taylor, collector.

Diagnosis. Characterized by a hexagonal frontal more than twice as wide as the supraocular, a single postocular, a single preocular touching nasal; mental touching chinshields; temporals 1+1+1; labial preceding last, very low; second labial not in contact with the preocular; 7-6 upper labials, 6-6 lower labials; anal divided; ventrals 129, subcaudals 53.

Description of the type: Length of the portion of rostral visible above distinctly more than half the distance of rostral from frontal; internasals rather small, about equal to half or a little more than half the length of the prefrontals; frontal hexagonal, longer than wide (2.3 x 2 mm.), distinctly more than twice the width of the supraocular; the posterior angle of frontal acute, the anterior obtuse; parietals large (3.2 x 2.1 mm.), a little longer than distance from the end of the snout; supraoculars only slightly wider posteriorly than anteriorly; nasal divided, posterior nasal smallest, slightly larger than the preocular, the outer angular edge of the prefrontal pushing down somewhat between the two scales; preocular longer than high; diameter of eye a little less than half the distance of eye from tip of snout; one postocular; temporals 1 + 1 + 1, the anterior large, wide, touching the postocular and broadly in contact with the seventh (or sixth) labial; second, small, square; third somewhat smaller than first; upper labials in the following order of size (left side) 1, 2, 5, 3, 4, 6; (right side) 1, 2, 6, 5, 3, 4, 7. It is the fourth scale of the left side that is divided (perhaps abnormally); last labial wider than high; second labial lower than third, and not touching the preocular;

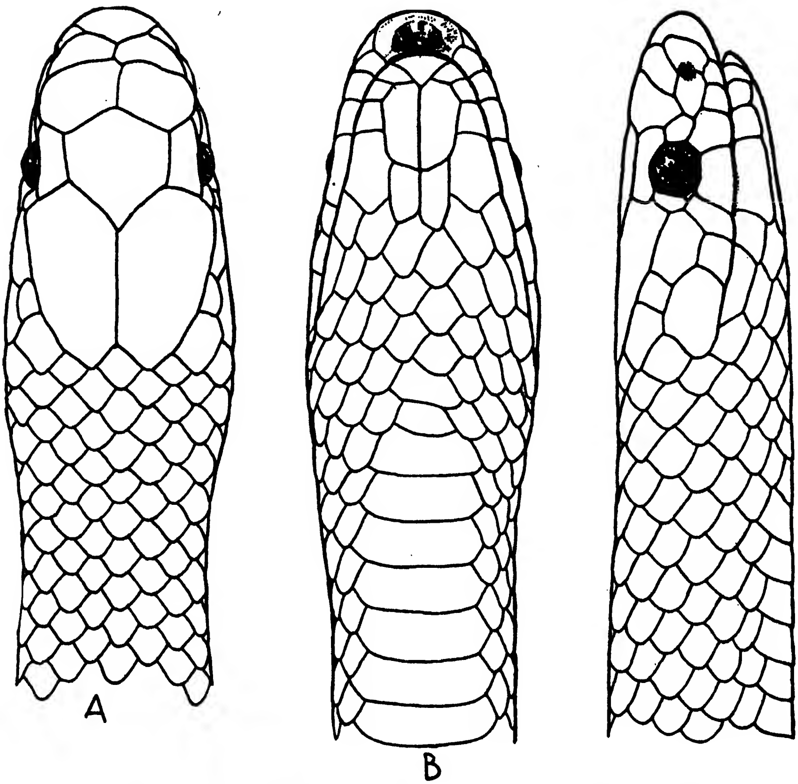

Fig. 2. *Tantilla hobartsmithi* sp. nov. EHT No. 4558, type. Width of head, 5.0 mm. Dorsal view (A), ventral view (B), and lateral view (C) of head.

six lower labials, first pair separated by mental, which touches the first chinshields; second pair of chinshields about half the size of first pair, separated from ventrals by three paired and two larger scales; scale formula 15-15-15; anal divided; ventrals 129; subcaudals 53 (male).

Color in life. Head brown, a light tan or yellow-tan on the snout, becoming black-brown or an indefinite brown on back part of head. White nuchal spots or collar; body anteriorly tan, becoming more faun posteriorly, each scale with some small brownish flecks forming indefinite lines on all save outer scale row. The median scale row with a hair-fine black line continuous on the greater part of the body. Whitish on the underside of head and anterior part of body; cream to cream yellow posteriorly.

Remarks. A single specimen was collected at night on the edge of a dry stream bed in the low mountains near the coast, near La Posa, Sonora. The specimen was observed running with most surprising rapidity over rough, gravelly terrain, under low shrubs. I succeeded in capturing it only with the greatest difficulty.

The relationship of this form is probably with *eiseni.* From this species

it differs in having a wider frontal, in the narrow supraoculars, in the character, shape and number of temporals, in the general character of the labial series, in having one instead of two postoculars, the very much lower scale count—ventrals 129 (instead of 163-181) and subcaudals 53 (instead of 58-70). It differs also in the details of markings. From *wilcoxi* it differs in having the mental in contact with first pair of chinshields, a wider frontal, one postocular, fewer ventrals (*wilcoxi* 150) and a much smaller eye. It also lacks a white collar followed by a black band, and it varies in other markings.

It is related in some measure to *T. atriceps,* differing in details of markings, one postocular and the character of the temporals.

Tantilla nigriceps Kennicott

1860. *Tantilla nigriceps* Kennicott, Proc. Acad. Nat. Sc. Phila., Aug. 1860, p. 328 (Type description; types U. S. N. M. No. 4491, Fort Bliss, New Mexico, Dr. Crawford, collector; and U. S. National Museum No. 2040, Indianola to Nueces, Texas, Capt. Pope, collector).

The original description of *nigriceps* is very brief. It follows:

"*Specific character.* Form more slender and head narrower than in *T. gracilis.* Vertical plate more elongate posteriorly, occipitals narrower, one ante-

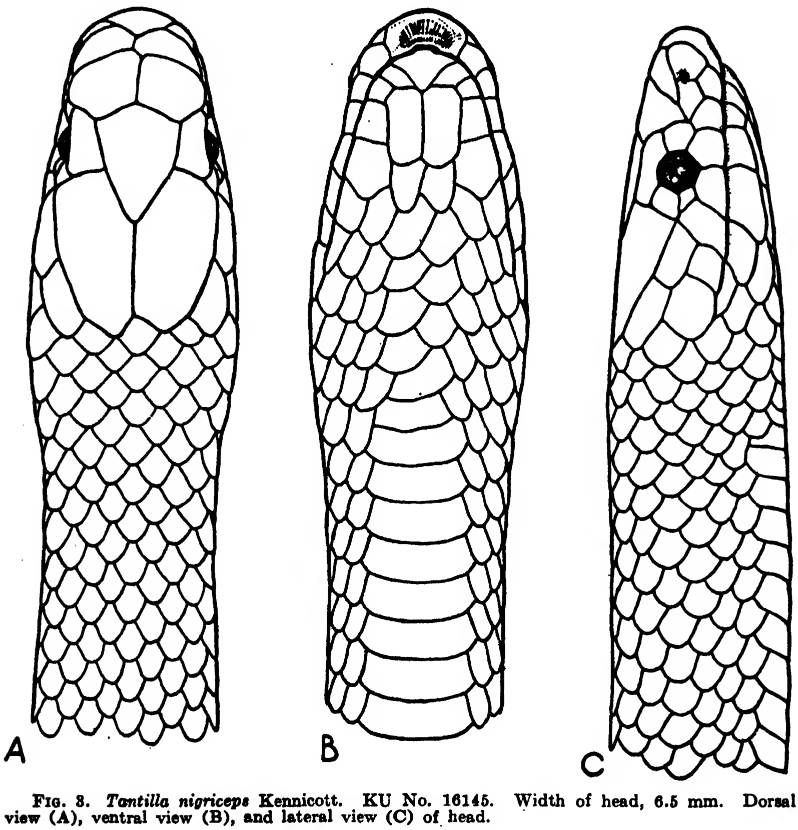

FIG. 3. *Tantilla nigriceps* Kennicott. KU No. 16145. Width of head, 6.5 mm. Dorsal view (A), ventral view (B), and lateral view (C) of head.

orbital, two postorbitals. Seven upper labials. Color (in alcohol) uniform brownish above, lighter beneath. Crown as far as behind the occipitals deep black; no indication of a postoccipital black ring as in T. *coronata*."

The following month, September, 1860, in the same journal, Cope described *Scelecophis fumiceps*, with a type locality, "probably Cuba," from a specimen in the Museum of Comparative Zoölogy, Cambridge, Mass. This he later places in the synonymy of *nigriceps* (Catalogue of Crocodilians, Lizards and Snakes [1900]). This specimen has: "Temporals two large and two small, ventrals 132, subcaudals 42; length 5 inches; tail 1 inch 10 lines."

In 1883, Bocourt (Miss. Sci. Mex., Liv. 9, 1883, pp. 582-583, pl. xxxvi, figs. 8, 8a-8d [1886] describes *Homalocranion praeoculum* from "le Colorado" (probably the Colorado river, Texas). This specimen differs in having *two* preoculars, and the mental in contact with the first pair of chinshields; the head is shown as being narrow but the head marking is typical of the species known as *nigriceps;* the presence of two preoculars is probably anomalous.

In the Kansas University Museum there is a series of specimens from Kansas, Texas, Oklahoma, and New Mexico as follows: No. 1792, Cowley Co., K. U. Biol. Survey; 2557-2559, 6 miles N. Lockhart, Morton Co., E. H. Taylor, collector; 8432, Alva, Woods Co., Okla.; 8509, 1 mile north Carlsbad, Eddy Co., New Mexico, C. D. Bunker; 16833, Hays, Ellis Co., Leo Brown; 12603, Sylvan Grove, Russell Co., Kan., Brandhorst; 18003, Atascosa Co., Texas, A. J. Kirn; 18415-18416, Ness Co., Kan., J. Schoeppel; 2256, an old specimen, is labeled Douglas Co. (this locality is very doubtful, none having been taken there in recent years despite much collecting).

These specimens are all typical as regards the general markings, measurements and scale characters (with few exceptions). There is a distinct sexual dimorphism as regards tail length and the ventral and subcaudal scale counts.

The tail is 22.4 percent (average) of total length in the male; in the female it is 18.2 percent (average). The subcaudals of the male vary between 44 (Texas specimen) and 58, the average being 51; in the females 35-49, the average being 43.5. The ventrals in females vary between 149 and 159, the average being 153.4, while in males the range is 132 (Texas specimen) to 146, the average 140. The total specific variation of ventrals is 132 to 159, and 35 to 58 for subcaudals. (As in *gracilis* the southern specimens have lower scale counts.) The scale formula beginning 1 centimeter back of the head is 15-15-15. The specimens agree in the following characters: The fifth labial touches two postoculars, which are invariably present; the nasal and preocular are in contact narrowly in ten specimens, and barely separated in two specimens; the nasal scales are apparently joined together above the nostril; the mental is separated from the chinshields, and the first labials are in contact. The frontal has an obtuse angle anteriorly while the posterior angle is acute; in all specimens the frontal exceeds somewhat its distance from the tip of snout, and the parietals are longer than their distance from the tip of the snout. The frontal is usually twice as wide as the supraocular, but in three of the 12 specimens it is not double their width; the first temporal usually touches one postocular, or it may be minutely separated or minutely in contact with the lower postocular only.

The supralabials are 7-7, the lower 6-6, with four of them in contact with the anterior chinshields. The usual labial order of size is 1, 2, 3, 4, 6, 5, 7, but the order of the third and fourth may be reversed.

The distribution of this species is Texas, Oklahoma, Kansas, Colorado, New Mexico, and Arizona, overlapping the territory occupied by *Tantilla gracilis* narrowly in the northern part of the range, while in the south the overlap is several hundred miles.

Tantilla brevissima, sp. nov.

Holotype: No. 4557, collected at Tonolá, Chiapas (on top of a low mountain near the city). Paratype No. 4556, young, same locality. Taylor, collector.

Diagnosis: A small member of the genus, characterized by a large rostral, the frontal longer than wide, not twice as wide as supraocular; seven upper and six lower labials; one preocular and two postoculars. Posterior half of body orange to salmon, the color more or less evident above; a white bar on occiput; ventrals 116 to 125; subcaudals 28 to 31.

Description of the type: Rostral much wider than high, well visible above, the part visible equal to a bit more than half its distance from the frontal; internasal suture half that of the prefrontals; frontal hexagonal, the posterior angle very acute, the anterior very obtuse; frontal about a third wider than posterior part of the supraocular, and a third longer than its distance to end of snout; parietals a little longer than their distance from the end of the snout.

Nasal divided, much narrowed at point of contact with nostril; anterior moiety widened, thrust between and separating upper part of first labial from rostral; preocular small, in contact with the posterior nasal; two postoculars; supraocular much wider posteriorly than anteriorly; temporals 1-1, the anterior the shorter, barely touching seventh labial, the posterior narrower; upper labials seven, in the following order of size; 1, 2, 3, 5, 4, 6, 7, the first three of nearly the same size, the seventh more or less square, the posterior corner rounded; an enlarged scale is present posterior to the seventh labial which might be regarded as a temporal.

Mental separated from chinshields; first lower labials broadly in contact. Six lower labials, the first four touch the first pair of chinshields; second pair of chinshields very small; three pairs of scales and three fused scales between the posterior chinshields and the first wide ventral.

Scale formula, 15-15-15. Ventrals 116, subcaudals 28; anal divided, the left moiety divided transversely; the scale preceding enlarged and pointed medially.

Total length 151 mm.; tail 26 mm.; percentage of tail length to body length 17.1.

Color in life. Above the general color anteriorly is dark brownish; posteriorly there is a suffusion of orange color. The brown is distributed over each scale in a fine reticulation, a little heavier on the posterior edge of each scale; the ground color of the scales is grayish on the anterior part of body, posteriorly it is orange. Anteriorly on ventral surface the color is white; about one fourth of the length from the snout, the orange coloration begins. It becomes a bright reddish orange under posterior part of body and tail.

The head is blackish brown, with somewhat darker spots above eyes; a light yellowish transverse nuchal spot, involving seven scales and the edges

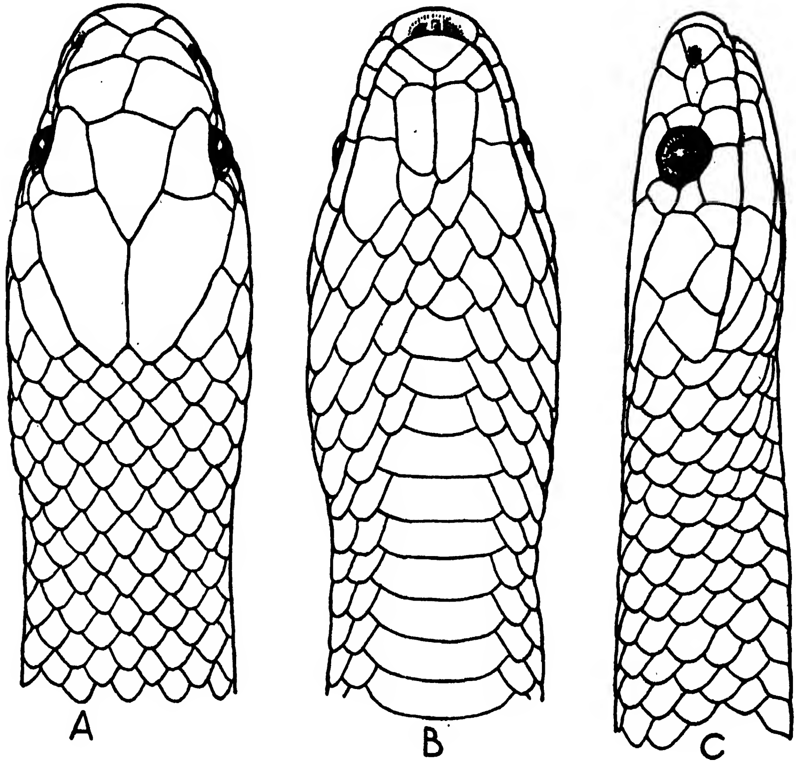

FIG. 4. *Tantilla brevissima* sp. nov., EHT & HMS No. 4557, type. Width of head, 4.3 mm. Dorsal view (A), ventral view (B), and lateral view (C) of head.

of the parietals; a white spot on the upper postoculars and one on the anterior tips of the supraoculars; yellowish spots on the prefrontals, and a large irregular yellow blotch covering parts of the rostral, internasals, and nasals. A white spot on the fifth labial connecting across the lower edges of the third and fourth labial to a yellowish spot on the second labial; light spots on two scales posterior to the last labial; a few minute brownish flecks on lower labials.

Variation: A young specimen taken at the same time has the head black with the same head markings save the spots on two scales following the seventh labial are absent; the outermost scale row which in the type was somewhat lighter than the rest, shows a distinct series of whitish spots, one on each scale, tending to disappear toward latter third of body. Outer edge of the ventrals are dark, this color showing very dimly in the type. The whole dorsal surface is darker, while the ventral color is the same as the type, save it is much less intense.

Tantilla calamarina Cope

1866. *Tantilla calamarina* Cope, Proc. Acad. Nat. Sci. Philadelphia, Nov. 1866, p. 320 (Type description. Type locality, Guadalajara, Mexico. I. I. Major, collector).

1876. *Tantilla bimaculata* Cope, Journ. Acad. Nat. Sci. Phila., (2), 7:148. 1876. (Type locality, Masatlán, Sinaloa, Mexico. Type description, Bishoff, collector); Bocourt, Mission Scientifique au Mexique, Liv. 9, 1883, pp. 580-581; and 1886, pl. XXXVI, figs. 6, 6a-6d.

A specimen (No. 4559) collected by Hobart M. Smith at Queseria, Colima, Mexico, has been referred to Cope's species. It appears to agree best with the details of his description of the species *bimaculata* which is from Mazatlán, Sinaloa. It is unquestionably of the species figured by Bocourt (*loc. cit.*).

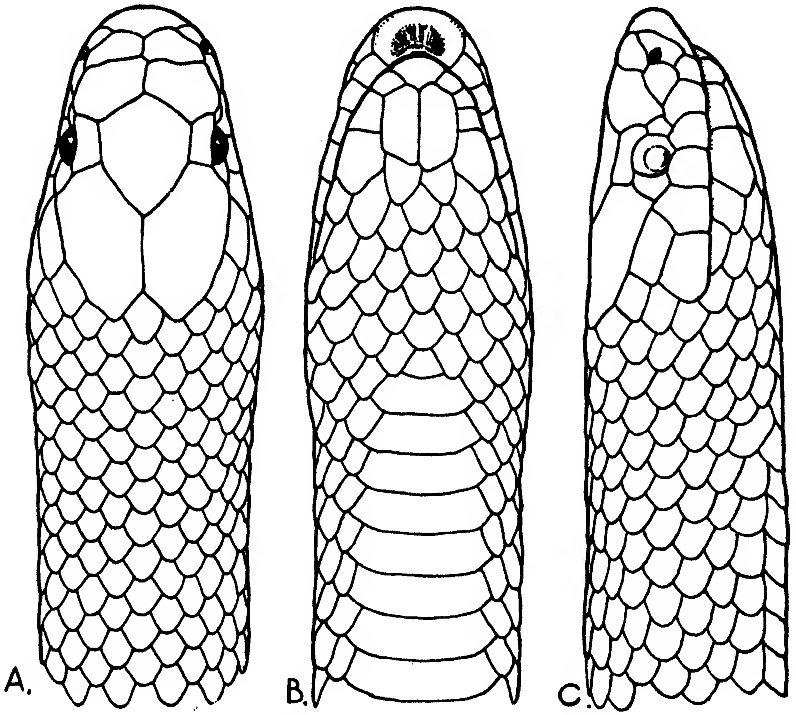

FIG. 5. *Tantilla calamarina* Cope. EHT & HMS No. 4559. Width of head, 5.0 mm. Dorsal view (A), ventral view (B), and lateral view (C) of head.

My specimen presents the following characters, certain of which do not wholly agree with either of the Cope descriptions.

Frontal obtusely angular in front, and with an acute angle behind approaching a right angle, at least three times the width of the supraocular; a moderately large postocular; a smaller preocular; nasals relatively very large, the nostril pierced at edge near the internasal; the posterior nasal in contact on left side with the preocular but separated on the right by the prefrontal, which touches the second labial but does not enter eye; the parietal touches the fifth labial on the right side and is narrowly separated from it on the left. Six upper labials, the fifth and sixth largest, subequal; 5-6

lower labials, the mental broadly in contact with the first chinshields; the first labial fails to notch the nasals below; second pair of chinshields one half or one third of its distance from end of the snout. Ventrals 131; anal divided; subcaudals 29.

Total length 205 mm., tail 31 mm.; percentage of tail length to body length 15.

The color of the scales is gray, each with fine, dark brown markings, ten or fifteen flecks on a single scale. Those on the median scale row and the halves of the adjoining rows a little heavier, forming a dim darker medial line from tip of tail to head, where it seems to widen to cover the top of head; scales of the fourth and fifth row likewise have the flecking heavier, thus forming a scarcely discernible lateral stripe which anteriorly for two centimeters back of head covers one and two half scale rows, continuing forward on side of head; a blackish transverse line unites the three bands back of the parietals and encloses two light areas on the back part of the parietals and the scales adjoining; the labials, save a part of the lower border, dark; scales of the rows between the darker lines are flecked more lightly with brown, the flecking continued onto the edge of the ventrals. There are three ventral areas where the minute punctate brown spots are present on the ventral scales suggesting that the specimen might have been dimly banded; the intervening areas whitish; the lower labials brownish.

Tantilla martindelcampoi, sp. nov.

Holotype: No. 4550, collected near El Treinta, Guerrero, on the Mexico-Acapulco Highway, June 29, 1932. E. H. Taylor, collector.

Diagnosis. A small species, perhaps allied to *T. depressa* Dunn. Characterized by a frontal approximately four times as wide as the supraocular; parietals longer than their distance from the end of the snout; part of rostral visible above little more than half its distance from the frontal; upper labials 6-6; lower labials 6-6; no preocular; one postocular; temporals 1 + 1. Prefrontal enters the eye; mental broadly in contact with the first chinshields; scale rows 15-15-15; ventrals 114; subcaudals 39; anal divided.

Description of the type: Head only moderately depressed, the part of rostral appearing above triangular, its length somewhat more than half the distance from the end of frontal; internasals only about one half (or a little less) the width of the prefrontals; their common suture, however, nearly equalling that of the prefrontals; prefrontals entering the eye, and in contact with the second and third labials; frontal hexagonal, longer than its distance from the end of snout, shorter than the parietals, from three to four times as wide as the supraocular; the posterior angle approaching a right angle, the anterior obtuse; nasal divided, the nostril chiefly in anterior part, the posterior part touching two labials; postocular rather small; temporals 1+1, the anterior long, slender, touching the postocular; labials in the following order of size: 1, 3, 2, 4, 5, 6, 7; the last labial low and elongate, the third and fourth entering the eye; six lower labials, four touching the first chinshields, which are nearly twice as large as second pair; the latter separated from ventrals by a series of 4 paired scales and one single scale. The scale formula is 15-15-15; anal divided; ventrals 114; subcaudals 39.

Color in life: Generally grayish white, with three broad stripes on body continued on tail; the median covering the median and half of the adjoining

scale rows; on the head it widens, becoming spatulate, extending to rostral, leaving only the outer rim of the parietals light; a stripe across each of the prefrontals, which is a continuation of a horseshoe-shaped mark on snout. Lower part of the labials whitish; the lateral dark stripe covers half of the fourth and fifth rows, running forward to rostral through eye, connecting above eye with the spatulate spot on head; the scales of the sixth and seventh rows each with a brown spot on the posterior part of the scale, thus forming two dotted lines; the scales of the second and third rows each with an elongate dot, forming dotted lines the length of body; lower labials, ventrals, and subcaudals immaculate.

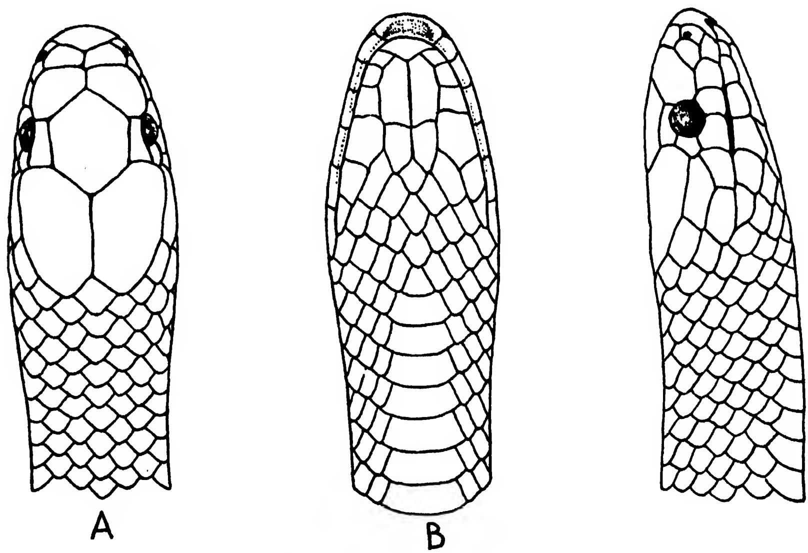

FIG. 6. *Tantilla martindelcampoi* sp. nov., EHT & HMS No. 4550 type. Width of head, 2.8 mm. Dorsal view (A), ventral view (B), and lateral view (C) of head.

Remarks: This species shows some relationship with *depressa* and *calamarina*. It differs from *depressa* in having a shorter rostral, longer parietals which are greater than their distance from the snout, in lacking a preocular, a higher number of upper and lower labial scales, no lower labial scales in contact with the parietal. The markings apparently are completely different.

From *calamarina* it differs in the absence of a preocular, the prefrontals touching labials and entering eye; in having the labials and parietal separated by the temporal scales; also in the details of the coloration of the head. The head is distinctly more flattened than in *calamarina,* and a lower ventral and higher subcaudal scale count obtains.

The specimen was dug up from the base of a forest tree where the earth consisted of rotting leaves and bark.

The species is named in honor of my friend, Sr. Rafael Martín del Campo, curator in charge of the National Museum of Natural History in Mexico City, who has shown me many courtesies and assisted in many ways my exploration work in Mexico.

New Species of Amphibia from Mexico

EDWARD H. TAYLOR, Kansas University, Lawrence, Kan.

For the past four years I have been segregating at the University of Kansas a collection of Mexican Amphibia with a view of treating the group monographically. In my preliminary studies several forms which are new have been discovered, and descriptions of these are to be published in advance. In the present paper the three following species are described: *Leptodactylus occidentalis, Eleutherodactylus pygmaeus, Eleutherodactylus hobartsmithi,* and *Hyla smithii* is redescribed from new material.

Leptodactylus occidentalis, sp. nov.

(Plate 1, figs. 1, 2, 7.)

Holotype: Adult female EHT No. 3322, Tepic, Nayarit, Mexico, July 28, 1934, E. H. Taylor, collector. "Taken at night in a pool near railway at edge of city."

Paratypes: No. 3301, about 10 miles south of Presidio, south of Mazatlán, Sinaloa; Nos. 3311, 3312, one to two miles east of Mazatlán, Sinaloa; Nos. 3313-3353, Tepic, Nayarit, July 28-31, 1934; Nos. 3354, 3355, Tepic, Nayarit, August 14, 1935. All collected by E. H. Taylor.

Diagnosis: Related to *Leptodactylus melanonotus,* the males having two well-developed horny spines on the thumb; fingers free, the first longer than the second; toes with only a vestige of web, but with dermal fringes extending to base of distal phalanges; a glandular area behind each jaw, one on breast posterior to each axilla and a diagonal one on the distal posteroventral side of femur, all covered with a horny brown excrescence. Skin of body above and on limbs covered with small pustules arranged for the most part in rows, the outer dorsolateral ones larger, each pustule surmounted with a small, brown, horny spine. Head narrow, its width contained in body length approximately three times (very slightly more or less); dorsolateral glandular fold more or less distinct, evidenced in many specimens by a brownish horny covering; eye less than length of snout; diameter of tympanum more than one half length of eye.

Description of holotype: Body normally slender (now somewhat distended with eggs), the head narrow, oval in outline, the snout projecting slightly; the narrowest interorbital distance about one fourth greater than width of an upper eyelid; length of eye a little more than three fourths of the length of the snout; snout lacking canthi; loreal region broadly oblique, slightly concave; the distance of eye to nostril much greater than nostril to tip of snout; distance between nostrils subequal to interorbital distance; tympanum distinct, its greatest diameter equal to a little more than one half the length of eye.

Tongue elongate, oval, emarginate medially behind, free for nearly one third its length; vomerine teeth in two groups, each double the diameter of a choana, lying some distance behind choanae, the distance between their outer edges slightly less than distance between choanae; choanae small, about one half millimeter in diameter.

Body and hind limbs thickly studded with small, low, conical, granular pustules, smaller medially, each with a tip of deep brown horn; snout smooth, forearm with none or only very few pustules; a well-defined horn-covered gland, longer than deep, behind angle of jaw; dorsolateral glandular fold low, rather indistinct, continuous for more than half the length of body, more or less covered with horny material; a second fold arising slightly lower, beginning below posterior corner of the eye, runs back over the tympanum to forearm, parallel with the large gland behind jaw angle, and separated from it by a narrow groove; the pustules on the body are arranged in rows, of which some 16 rows can be discerned, those on the sides usually more distinct, the pustules being larger; the pustules following a light lateral line are largest, some being partially covered with horny material; anteriorly this row intersects the supratympanic fold, and the pustules form a more or less continuous fold.

The ventral surfaces of the chin, throat, and abdomen are quite smooth; a ventral body disk is more or less evident, being obscured by the distention of the body with eggs; the posterior limit is definitely marked with a transverse groove (entire disk more clearly evident in males); about half of the ventral femoral region is covered with smooth granules and on the posterior part the granules form a triangular area including the anus, the granules being capped with horn. On the distal postero-ventral part of the femur is a large glandular area covered with a brown, horn-like excrescence. The glandular areas on the postaxillary region of abdomen are large, flat, and likewise covered.

Arms short, the arm laid forward, only the free parts of fingers extend beyond the tip of the snout; the thumb is slightly longer than the first finger, but when laid side by side, they reach forward approximately the same distance. A large, raised, oval, palmar tubercle on the base of thumb; the small medial tubercle is joined to the larger, outer palmar tubercle; subarticular tubercles large, and some supernumerary tubercles evident on the palm; fingers free; on inner side of the second and third finger a microscopic fringe is present, beset with minute corneous spicules.

Hind leg moderate, the tibiotarsal articulation reaching to the tympanum or slightly farther; toes slender, not enlarged at tips, all with a narrow dermal fringe continuous between the toes (suggesting a slight webbing) and extending to base of distal phalanx on each finger; subarticular tubercles prominent; no supernumerary tubercles, but the granular pustules of the leg are more or less evident on sole; a very strongly defined tarsal fold present, edged with minute horny spicules and more or less covered with a brown, horny excrescence; inner and outer metatarsal tubercles about equal in size; a very slight fold on outer side of fifth metatarsal; when femurs are placed at right angles to body the heels overlap about two millimeters; third toe longer than fifth.

Color in life: The general dorsal coloration is blackish or brownish gray, tinged with bronze and with some darker markings; a triangular blackish mark ending posteriorly in two points is evident; the dorsolateral glandular folds are brown anteriorly, and there are some blackish spots along the folds posteriorly; in the median dorsal region are darker spots, paired or enclosing slightly lighter areas; the triangular spot on head is bordered with a light line tinged with red; from eye to forearm is a line tinged with red (yellow in

Table of Measurements of *Leptodactylus occidentalis*, sp., nov., in millimeters.

Number	3,322	3,343	3,315	3,314	3,323	3,325	3,335
Sex	♀	♀	♀	♂	♂	♂	♂
Snout to vent	38	35.4	33.5	31	30	30	32
Head width	12.8	11.8	11	11	11.2	10.3	11 5
Head length	11.8	11.4	11.2	11	10.2	10	10.2
Diameter of tympanum	1.8	1.8	1.6	1.6	1.5	1.7	1.6
Diameter of eye	3	3	3	2.9	2.8	3.1	3
Length of snout	4.5	4.6	4.4	4.5	4.3	4.4	4.6
Interorbital width	2.2	2.2	2.2	2.1	2	2.2	2.3
Foreleg	16	15.2	14.5	15	15	13.5	16
First finger	4	3.8	3.8	3.5	3	3	3.2
Second finger	3.6	3.4	3.5	3.1	2.8	2.8	3
Hind leg from anus	46.5	45	47	43.5	42	43.5	44
Tibia	15.6	14.2	14	13	13.1	13.2	14
Foot	23	24	22.5	23.2	21.8	22	22.2

3,313
♂
31
10.8
10.2
1.5
3
4.3
2.2
14.8
3.3
3
43
13
23

preservative), the red more pronounced posteriorly than anteriorly. The front legs are gray brown, with a tinge of red on upper surface of the humerus; hind legs lighter gray-olive, barred with darker and with some dirty white flecks; a light, reddish-yellow streak from eye to groin on the sides; ventral surfaces generally cream, but under the microscope slight pigmentation is evident on the chin; glandular areas deep brown; soles of feet lavender to slate gray.

Variation: In the large series before me there is considerable variation in the details of the dorsal coloration. Usually the area between the dorsolateral glandular folds is lightest, and the area between this and the light lateral streak is distinctly the darkest part of the dorsal coloration.

The males are darker under the chin and throat than the females, and sometimes these darker areas may show tiny whitish or yellowish spots as may the darker area low on the sides; the under side of the legs may show some pigmentation in males; the posterior surface of the femur is dimly reticulated, with a light spot surrounding the anus. There is sharp contrast on the posterior side of tibia between the yellowish ground color and the dark blotches. The males have two sharp, heavy, horny spines arising from the inner surface of the thumb. The soles and palms are of a deep lavender color generally. The males have vocal sacs which may be indicated externally by a chin fold near the edge of jaw.

Remarks: The narrow head, the small maximum size (38 mm. for females, 33 mm. for males), the character of the postaxillary and postfemoral glands, the narrower groups of vomerine teeth, clearly distinguish this western Mexican form from the more robust, larger *melanonotus* to the south. The call is likewise fainter and different in quality.

Specimens were breeding apparently, but no eggs were encountered at Tepic. Many of the females taken at the same time have deposited their eggs, while several besides the types have not done so.

There is a possibility that the horny excrescence covering the glands may appear only during the breeding season. This character is quite as strongly marked in females as in the males.

Eleutherodactylus pygmaeus, sp. nov.

(Plate 1, figs. 3, 4)

Holotype: EHT No. 3691, adult female with ripe eggs; 1 mile north of Rodriguez Clara, Vera Cruz, Sept. 7, 1935; E. H. Taylor and Hobart M. Smith, collectors.

Paratypes: No. 3690, same locality and date, adult female with ripe eggs; No. 3689, 12 miles south of Chilpancingo (2 miles north of Mazatlán), Guerrero, June 26, 1932. All collected by E. H. Taylor and Hobart Smith.

Diagnosis: A diminutive leptodactylid, lacking evidence of vomerine teeth. Dorsal skin rough, corrugated, with elongate tubercles or folds arranged somewhat in lines; a scapular / \-shaped mark (absent or dim in one paratype). Interorbital space wider than eyelid; length of eye a little less than length of snout; a well-defined ventral disk with a slight fold across breast; lateral and posterior parts of the disk indistinctly granular or areolate; ventral surface of femur granular on the proximal portions; tibiotarsal articulation reaches

to posterior part of eye; none or only a mere trace of membrane between toes; no web between fingers; toes and outer fingers widened somewhat, forming small but distinct terminal disks; limbs and feet with numerous darker bars; chin and throat pigmented; abdomen whitish or flesh, without pigment; tongue oval.

Description of holotype: Head nearly flat above, the depth of head at tympanum but slightly greater than at nostril; canthus rostralis rounded, rather than angular, snout somewhat constricted posterior to the nostrils; latter well back from end of snout, which is rounded, in dorsal and lateral profile, extending a millimeter beyond the mouth; loreal region strongly oblique, not or but very slightly concave; tympanum large, its diameter distinctly more than half the length of the eye, its vertical diameter slightly greater than the horizontal; eye a little longer than its distance from the nostril, but distinctly wider than the greatest width of an upper eyelid; a slight supratympanic fold, not overlapping tympanum and is not or but dimly extended behind tympanum; a distinct glandular fold, somewhat behind angle of jaw, running back from tympanum (may be divided and form two tubercles); a few short folds and tubercles forming indistinct lines on the shoulder (more distinct in No. 3690, where anteriorly there are six rows; that originating at the posterior corner of the eye continues back to groin); a median, more or less continuous fold of about a hair's width; a pair of interscapular diagonal folds which are somewhat curved, just failing to meet medially, forming a / \\-shaped figure (apparently wanting in No. 3690, but present in No. 3689). Remainder of dorsal surface finely corrugate; sides indistinctly granulate or areolate anteriorly, nearly smooth posteriorly; chin, breast and anterior medial part of abdomen smooth; posterior, and to some extent the lateral, part of abdomen granular or areolate; the ventral disk, the edges of which are indicated by a slight fold, are moderately distinct in type (more so in No. 3690).

Limbs rather short, the arm brought forward, only the free part of fingers extending beyond snout; two or three slight tubercles in a row on under side of arm; first finger distinctly shorter than second; two palmar callosities, a large oval medial one, and a smaller one on the base of the first finger; subarticular tubercles strong; three small supernumerary tubercles on the palm; terminal disks of two outer fingers wider than digits, those of inner fingers of about same width as digit; legs folded at right angles, the heels overlap about three fourths of a millimeter; the tibiotarsal articulation reaches the posterior edge of eye; the inner metatarsal tubercle reaches the nostril; no trace of a tarsal fold; inner metatarsal tubercle large, salient, its length contained one and one half times in first toe; outer tubercle less than one third as large, conical, nearly on a level with the posterior part of the inner; subarticular tubercles well developed but lacking all save a slight trace of supernumerary tubercles on digits and sole; legs above with numerous pustular tubercles; most of the proximal ventral part of the thighs, and the posterior part below anus granular. Free part of the fourth toe more than twice as long as the free part of the fifth.

Color in life: Above purplish, obscuring the dorsal markings. When submerged in alcohol under a strong light an interorbital bar is visible, a darker interscapular area and a mid-dorsal blackish spot. Other minute dark flecks

and vermiculations are likewise evident; upper lip with four large dark spots separated by slightly lighter interspaces; a small dark irregular line across tympanum extending somewhat behind; below the posterior part of this is an elongate light spot. A dull light elongate spot on upper arm; distal part with dark bars; the fingers barred with darker and lighter; postaxillary region with dark reticulations, the groin almost pigmentless; legs with numerous bars forming continuous lines when limb is folded; posterior side of the femur darkly pigmented with a lavender brown; under surface of tibia less heavily pigmented; toes barred with broad dark and narrow light bars; under surface of feet purplish, the tubercles light; chin and throat pigmented slightly; median and posterior part of abdomen lacking pigment.

Measurements of *Eleutherodactylus pygmaeus,* sp. nov., in millimeters

	No. 3691	*No. 3690*
Sex	f.	f.
Snout to vent	18	18
Snout to eye	2.4	2.35
Length of eye	2.1	2.2
Diameter of tympanum	1.3	1.45
Interorbital distance	1.8	1.8
Upper eyelid	1.55	1.6
Foreleg	9.3	9
Hind leg from anus	25.2	26
Tibia	9	9.2
Foot	12.6	12.1
Free part fourth finger	5.2	5.4
Free part fifth finger	2.4	2.6

Variation: While the specimen No. 3690, taken at the same time and within a few feet of the type, agrees in most structural details, the / \-shaped fold is wanting on the back and the rows of folds and tubercles are more pronounced; the dorsal coloration is strikingly different. There is a median pair of dim bars on the snout and another more distinct on the loreal region; the black interorbital bar forms a V-shaped mark, the two parts not joining medially but continue back as two rather broad stripes with irregular edges to end of body; another stripe beginning behind each eye is carried back to the groin; the chin and throat are less densely pigmented and the dim rounded cream spots are somewhat less distinct than in the type.

The specimen from near Chilpancingo is a little larger, measuring about 21 millimeters. The skin is somewhat smoother but in general the characters are much the same. A / \-shaped black mark shows the location of the fold which here can scarcely be discerned.

Remarks: The type and one paratype were collected in a small group of trees near a brook in the savanna near Rodriguez Clara, Vera Cruz, Mexico. During a shower the specimens of this species were hopping about the ground on wet leaves. Several calls were heard in the undergrowth, but no males were discovered. The exact habitat of the specimen from near Chilpancingo was unfortunately not recorded.

Despite the absence of vomerine teeth I have associated this form with *Eleutherodactylus* rather than with *Syrrhophus,* since in most of the generic characteristics it resembles the former.

Eleutherodactylus hobartsmithi, sp. nov.

(Plate 1, figs. 5, 6.)

Holotype: EHT and HMS No. 3688; collected near Uruapan, Michoacan, July 19, 1935, by Hobart M. Smith.

Paratypes: Nos. 3686, 3687, from the same locality, same date and collector.

Diagnosis: A diminutive species characterized by the absence of vomerine teeth, the absence of any trace of a web between fingers or toes, and the presence of small truncate disks with a terminal groove; the free part of the fifth toe is much less than half the free part of the fourth toe. The eye is shorter than the snout, while the tympanum is as large as or slightly smaller than the eye; the interorbital distance is one and one half times the width of an upper eyelid; a ventral disk present; two metatarsal tubercles, not differing greatly in size; no tarsal fold. Some pigment present on inner side of the anterior part of the jaw.

Description of the holotype: Head rather oval in its anterior outline, the snout not pointed; canthus rostralis distinct, somewhat rounded rather than angular; loreal region subvertical, not concave; tip of the snout extending about half a millimeter beyond mouth; eye small, not prominent, much less than its distance from the end of snout, but distinctly longer than its distance from nostril; interorbital distance one and one half times the width of an upper eyelid; tympanum very large, very distinct, its diameter equaling, or minutely less than eye, separated from the eye by a distance equal to about one fourth of its diameter.

Tongue somewhat oval, apparently without trace of a posterior emargination, thickened and rounded posteriorly, free for less than one fourth of its length; internal nares small, widely separated, nearly concealed by overhanging jaw; no trace of vomerine teeth when examined under a lens; eye pupil apparently horizontal; vocal sacs present but no fold evident on chin; skin smooth generally; a slight supratympanic fold, scarcely discernible; two tiny glandular tubercles posterior to lower edge of tympanum; sides with very indistinct, minute folds or tubercles, and a few indistinct ones on the posterior part of back; ventral surface smooth on throat and chest, but showing some evidence of granular structure posteriorly; a ventral disk dimly evident; limbs smooth; a more or less triangular area behind and below anus.

Apparently no trace of a web between the fingers; a distinct tubercle at base of first finger and a well-defined median palmar tubercle; no outer palmar tubercle; the basal subarticular tubercles well defined; the outer tubercle on third finger reduced, that on fourth finger apparently absent; palm with a few supernumerary tubercles; tips of fingers rounded, very slightly wider than digits, truncate at tip; arms smooth, without granules; tibiotarsal articulation reaches to anterior edge of eye; when limbs are folded at right angles the heels overlap; toes with somewhat widened terminal disks, truncate at tips and with an anterior groove; the digits rather flattened, with well-defined subarticular tubercles and occasional, very small supernumerary tubercles, those on sole scarcely discernible; a pair of metatarsal tubercles, the inner not or but slightly larger than outer; the free part of the fifth toe distinctly less than half as long as the free part of the fourth; the third and fifth toes reach forward an equal distance; length of

the inner metatarsal tubercle about one fourth the length of the first toe; apparently no trace of a tarsal fold.

Color: Above an indefinite gray, the head of a dark bluish-gray with a slightly darker interorbital line; in the interscapular region there is present an inverted V-shaped black mark and traces of a darker median line on the anterior part of the body; two small dark spots on the rump. A dark line from tip of snout through nostril to eye and a deep black postorbital line running above tympanum; the anterior part of side has more pigment than the posterior; limbs rather indefinitely barred with darker color; chin, throat and abdomen with a minute peppering of dark pigment; the ventral and posterior surfaces of limbs and feet are likewise pigmented; the postanal region darker than the remainder of femur; inside of mouth on the terminal part of upper jaw with some dark pigmentation.

Table of Measurements of *Eleutherodactylus hobartsmithi*, sp. nov., in millimeters.

	No. 3688	*No. 3686*	*No. 3687*
Sex	m.	m.	m.
Snout to vent	14.4	14.1	12.1
Length of snout	2.0	2.0	1.8
Snout to foreleg	6.0	5.8	5.5
Diameter of eye	1.6	1.8	1.6
Tympanum	1.8	1.95	1.6
Interorbital width	2.0	1.8	1.8
Upper eyelid	1.2	1.3	1.0
Foreleg	8.7	8.3	8.2
Hind leg from anus	25.0	21.0	20.5
Tibia	7.0	7.3	6.9
Foot	9.5	10.7	8.9
Free part fourth finger	4.6	4.6	4.3
Free part fifth finger	2.1	2.2	2.0

Variation: The two paratypes differ but little from the type save that certain characters are more distinct. No. 3686 has the skin on the dorsal surface showing minute folds or tubercles, which appear less distinct on head, save in the supraorbital region; the upper lip shows some darker spotting or marbling. There are some darker spots scattered on the posterior part of the back and the barring on the limbs is more distinct. The ventral disk is more distinct and has the granules slightly more distinct posteriorly.

No. 3687 agrees largely with the preceding save that the loreal stripe is reduced to a spot, and the postorbital line does not reach the eye and forms only a curved spot above the tympanum. A single posttympanic tubercle is present; the granulation on the ventral disk is distinct. The inner metatarsal tubercle is distinctly larger than the outer.

Remarks: In Hobart Smith's field notes he remarks that these tiny leptodactylids were taken from bushes and trees very near the ground while singing. Its call is a very feeble, single chirp, which is repeated once every one and one half to two minutes. One was observed making the sound. The whole body is inflated as much as possible, then suddenly the body is deflated as the chirp is produced.

None were found on the ground, probably because their small size and their protective coloration when on the ground among dead twigs and leaves make them difficult to find. They were extremely difficult to collect even though they were heard everywhere.

There are no females in the lot. The males are apparently sexually mature. The testes are large and their covering is coal black. The stomach contents of one specimen included several tiny Coleoptera, Diptera and Homoptera.

This form has been referred to *Eleutherodactylus* rather than *Syrrhophus* as the loss of the vomerine teeth has been acquired apparently independently from different original stock from that from which *Syrrhophus* has been derived.

Hyla smithii Boulenger

(Plate 2, figs. 1-5.)

SYNONYMY

Hyla nana Günther, Biologia Centrali-Americana, Reptilia and Batrachia, June, 1901, p. 263. (*Nec Hyla nana* Boulenger 1899.)

Hyla smithii Boulenger, Zoöl. Rec., 38 Rept. Batr., p. 33, 1902.

Hyla eximia (part) Kellogg, Bull. U. S. Nat. Mus. No. 160, 1932, pp. 164-168.

The following specimens have been examined: Nos. 2168-69, 11 miles south of Puente de Ixtla, Guerrero, June 22, 1932, E. H. Taylor and Hobart M. Smith; 2170, 2172, near Mazatlán, 12 miles north of Chilpancingo, Guerrero, June 26, 1932, E. H. Taylor and Hobart M. Smith; 2173, two miles north of Mazatlán, Guerrero, July 2, 1932, E. H. Taylor and Hobart M. Smith; 2174, two miles east of Mazatlán, Sinaloa, July 20, 1934, E. H. Taylor; 2175-2224, Tepic, Nayarit, Mexico, July 28, 1934, E. H. Taylor; 2225-2247, near Queseria, Colima, June 17-18, 1930 (1300 meters), Hobart M. Smith; 2248-9, Hacienda Paso del Rio, Colima, July 8, 1930, Hobart M. Smith; 2250-2267 Hacienda El Sabino, Michoacán, July 21, 1935, Hobart M. Smith; UMMZ 80019 (19 spec.), UMMZ Field Nos. 139, 141, Queseria, Colima, June 17, 1935, James Oliver; UMMZ 80020 (9 spec.), 80021 (14 spec.), UMMZ Field Nos. 354, 358, Hacienda Paso del Rio, Periquillo, July 25, 1935, James Oliver; UMMZ 80022, Rio Armeria, Colima, July 12, 1935, James Oliver.

Diagnosis: A small Hyla, with a maximum size of 30 mm. The tympanum is covered with thin skin, but its outline usually distinctly visible; snout short, obtusely pointed, a little longer than longitudinal diameter of eye, projecting beyond the lower jaw; interorbital region one and one half to twice the width of the upper eyelid; distance of eye from nostril slightly greater than distance between nostrils; vomerine teeth on small raised areas between choanae; tongue large, rounded or cordiform; tips of digits dilated, those of fingers as large as tympanum; a vestige of web between fingers, one half millimeter deep; toes nearly one half webbed; the greatest depth between outer toes about 2.5 millimeters; inner metatarsal tubercle flat, outer small, so indistinct as to appear wanting in many individuals; tibiotarsal articulation reaches to middle or anterior edge of orbit. Usually bright lemon yellow in life.

Description of the species: Snout not depressed, the depth at nostrials equals that of interorbital region; canthi slightly angular, their junction in front of nostrils forming approximately a right angle; in lateral profile the snout slopes down and forward to the most anterior part of snout, then abruptly slopes back and downward to the mouth; lores somewhat oblique, not at all concave; eyes prominent; the interorbital width more than one and three fourths the width of the upper eyelid; tympanum more or less distinct, its diameter a little

less than half diameter of eye and separated from corner of eye by a distance about equal to its diameter.

Choanae separated by a distance about equal to the distance between the nostrils; vomerine teeth in two low series directly between the choanae; tongue more or less cordiform (sometimes nearly round with the posterior emargination scarcely discernible;) skin above smooth, abdominal region with very large granulations; under surface of thigh with a strip of granules (sometimes indistinct).

Fingers with well-developed terminal pads; that of the middle finger equaling tympanum; subarticular tubercles well developed; a large elongate pad on outer ventral surface of first finger; palm covered with numerous flattened granules; first finger shorter than the second more or less opposed to other digits; a vestige of web between three outer fingers; none or only a slight indication of a dermal margin on fingers.

Hind limb moderately elongate, the heel reaching to middle of orbit. Toes with digital dilations smaller than fingers; the toes about one half webbed (or occasionally somewhat more, never reaching the terminal dilations); subarticular tubercles moderately prominent, the sole and proximal portion of toes with granules; inner metatarsal tubercle well defined, outer wanting or very dim (outer occasionally discernible). The tarsal fold is scarcely discernible (usually rather distinct in males); a fold present across the breast.

Color in life: (At night) the dorsal surface a bright lemon- or canary-yellow, bordered on the dorsolateral region by a silvery white (or sometimes golden) line, most distinct on the outer edge, and merging with the dorsal color on the inner; this may be traced to the tip of snout, and to groin (often indistinct but more strongly evident on the anterior half of body behind the eye); close examination reveals fine brownish pigmentation on all dorsal surfaces, more on the head region; sides likewise pigmented, the minute flecks forming a broad lateral stripe from snout to near groin, most

Measurements of *Hyla smithii* Boulenger in mm.

	No. 2179.	No. 2173.	No. 2263.	No. 2253.	No. 2259.	No. 2172.
Sex	♀	♀	♀	♂	♂	♂
Snout to vent	28.5	26	28	27	25.5	25
Eye length	2.9	2.85	3	3	2.8	28
Eye to tip of snout	3.7	3.7	4	3.6	3.4	35
Tympanum	1.35	1.2	1.2	1.3	1.1	1.2
Interorbital width	3.6	3.6	3.6	3.2	3.2	3.2
Upper eyelid	1.6	1.5	1.5	1.5	1.6	1.5
Foreleg	14	14.2	15	14	13.6	14
Hindleg from vent	40	37.5	41	47	36	38.5
Tibia	14	13.5	14	14.2	12.2	12.5
Foot	18	18.2	19	19	17	17.2

dense along the lateral silvery stripe; dorsal surfaces of the limbs including the suprafemoral region with minute flecks of dark pigment not forming bars.

In daylight the yellow color is less intense and the brown or grayish-black pigment is more intense and the body may appear grayish or brownish, the color usually most evident about head and interorbital region; (occasionally the flecks tend to form small spots, and rarely there is a suggestion of bars on the tibia); the vocal sac in males is very large and of a bright lemon-yellow color.

Variation: The vomerine teeth in very young specimens (as in many species) are not or scarcely discernible and even in adults the groups are low and occasionally difficult to see. Occasionally the tympanum can scarcely be discerned.

The chief color variations have already been mentioned.

Remarks: It seems very remarkable that this small species has remained so rare in collections since it does not appear to be rare and has a wide distribution in western Mexico. The specimens at Tepic were found ensconced in the leaves of floating water-hyacinth or (at night) perched on a leaf or flower. The males were calling, and two pairs were found clasping, although no eggs were discovered. Many hundreds were heard in the plants floating in the deeper parts of the ponds along the railway in the environs of Tepic. The single specimen collected near Mazatlán was found in a floating plant in a small rain pool.

Hobart Smith notes that the specimens from Queseria, Colima, were found clinging to grass and weeds and on the ground about a shallow rain pool, while those taken at El Sabino, Michoacán, were for the most part on the edge of a small rocky rivulet. One was found in the axil of a caladium.

I am under deep obligation to Mrs. Helen T. Gaige for help on this form. Specimens were compared with the types in the British Museum through the kindness of H. W. Parker.

EXPLANATION OF PLATE 1

FIG. 1. *Leptodactylus occidentalis* sp. nov. No. 3343, paratype ♀. Snout to vent 35 mm. Tepic, Nayarit, Mexico. E. H. Taylor Coll.

FIG. 2. *Leptodactylus occidentalis* sp. nov. No. 3322, type ♀. Snout to vent 38 mm. Tepic, Nayarit. E. H. Taylor Coll.

FIG. 3. *Eleutherodactylus pygmaeus* sp. nov. No. 3691, type ♀. Snout to vent 18 mm. One mile north of Rodriguez Clara, Vera Cruz, Mexico. E. H. Taylor and Hobart M. Smith Coll.

FIG. 4. *Eleutherodactylus pygmaeus* sp. nov. No. 3690, paratype ♀. Snout to vent 18 mm. One mile north of Rodriguez Clara, Vera Cruz, Mexico. E. H. Taylor and Hobart M. Smith Coll.

FIG. 5. *Eleutherodactylus hobartsmithi* sp. nov. No. 3688, type ♂. Snout to vent 14.4 mm. Uruapan, Michoacán, Mexico. Hobart Smith Coll.

FIG. 6. *Eleutherodactylus hobartsmithi* sp. nov. No. 3686, paratype ♂. Snout to vent 14.1 mm. Uruapan, Michoacán, Mexico. Hobart Smith Coll.

FIG. 7. *Leptodactylus occidentalis* sp. nov. No. 3347, paratype ♂. Snout to vent 30 mm. Tepic, Nayarit, Mexico. E. H. Taylor Coll.

PLATE 1

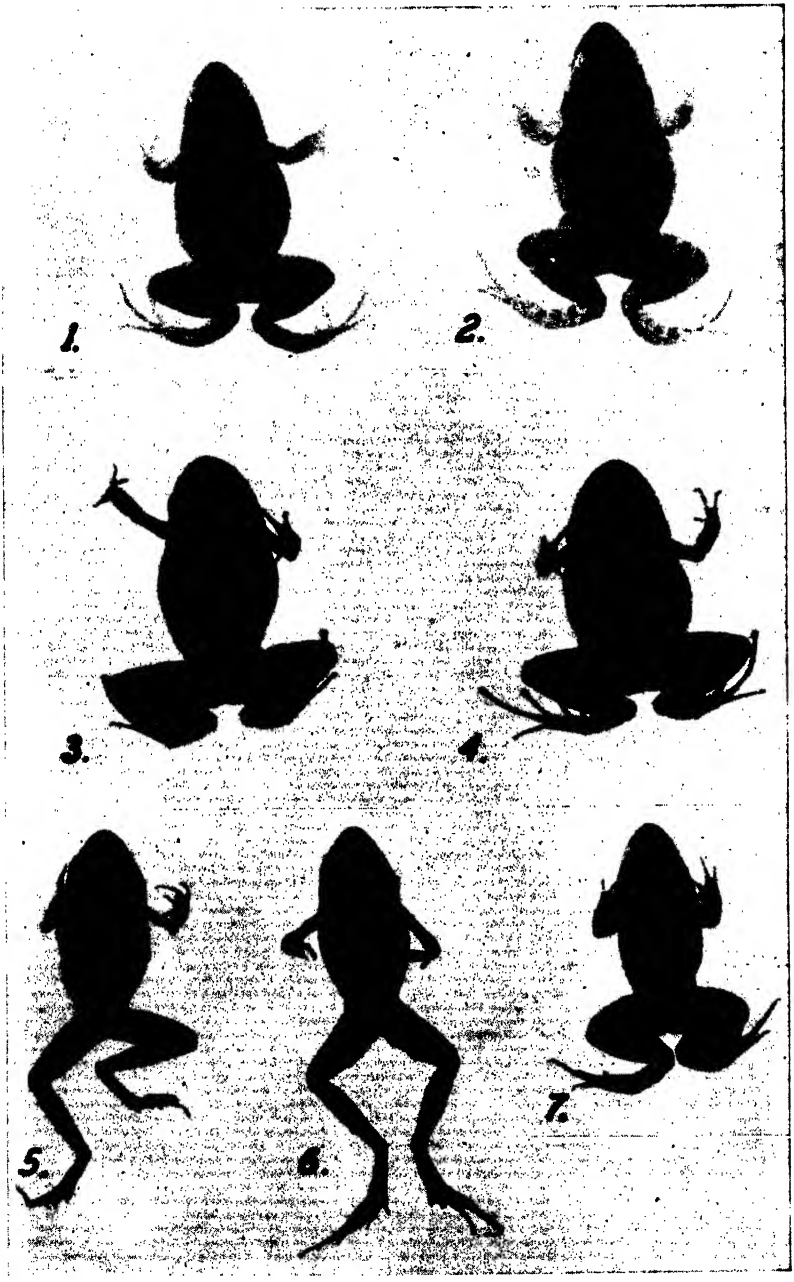

PLATE 2

FIG. 1. *Hyla smithii.* No. 2173, ♀. Snout to vent 26 mm. 12 miles south of Chilpancingo, Guerrero, Mexico. E. H. Taylor and Hobart Smith Coll.

FIG. 2. Same. No. 2179, ♀. Snout to vent 28.5 mm. Tepic, Nayarit, Mexico. E. H. Taylor Coll.

FIG. 3. Same. No. 2172, ♂. Snout to vent 25 mm. 12 miles south of Chilpancingo, Guerrero, Mexico. E. H. Taylor and Hobart Smith Coll.

FIG. 4. Same. No. 2170, ♂. Snout to vent 23 mm. 12 miles south of Chilpancingo, Guerrero, Mexico. E. H. Taylor and Hobart Smith Coll.

FIG. 5. Same. No. 2263, ♀. Snout to vent 28 mm. Hacienda El Sabino, Michoacán, Mexico. Hobart Smith Coll.

FIG. 6. *Hyla* sp. (Not described here.)

PLATE 2

Some Mammals of an Eastern Nebraska Prairie

DON B. WHELAN, University of Nebraska, Lincoln, Neb.

The study on which this paper is based was conducted on a piece of original prairie, containing about 320 acres, located nine miles northwest of Lincoln.

The material for this paper is based upon observations made during the years 1928 to 1930, and upon the animals caught in traps from March 27 to April 19, 1929. Mousetraps, baited with dry oatmeal, were used for the smaller mammals and a steel and a Maccabee trap employed for some of the larger species. Most of the traps were set on a low, level part of the prairie and in the near-by shallow ravines. Some were set on the high prairie, but there the animal life was not abundant. During the month of April there seemed to be an upward migration of rodents from the low prairie.

For a part of the material the writer was aided by Grace Kiernan Weber (Mrs. Walter J.), who worked with him and used a part of this material for a thesis.

The most abundant of all the animals trapped was the Baird white-footed mouse (*Peromyscus maniculatus bairdi*) (31.7%), with the prairie meadow mouse (*Microtus ochrogaster*) (29.26%) a close second, and the northern white-footed mouse (*Peromyscus leucopus noveboracensis*) (17.08%) third.

The following is a list of the mammals that were either caught or seen close enough to identify:

1. Little Short-tailed Shrew. *Cryptotis parva* (Say). One specimen was captured, on April 19, close to the runway of *M. ochrogaster*.

2. Large Short-tailed Shrew. *Blarina brevicauda brevicauda* (Say). Only one specimen was taken, April 19, on the low prairie, near the road.

3. Prairie Spotted Skunk. *Spilogale interrupta* (Rafinesque). On April 3, a steel trap, baited with old liver, was set in an opening in the side of a ravine bank. It was not molested until April 11, when this species was taken.

4. Say Coyote *Canis latrans* (Say). During 1928 one was seen on May 1 and May 24. In early September several were heard at night. In 1929, on March 14, the author came within thirty feet of one scared out of a bushy ravine. It ran about two hundred feet, stopped to look back, and then ran up over a hill on the prairie.

5. Thirteen-striped Ground Squirrel. *Citellus tridecemlineatus tridecemlineatus* (Mitchill). The earliest these animals were observed was March 29 and the latest was October 25. In the summer, when the grass is long, they are almost impossible to see on the prairie. During October those seen were fat and rather ungainly in their movements.

6. Shaw Pocket Gopher. *Geomys bursarius* (Shaw). During 1928 the earliest work noted was on April 26 and the latest in the year was on October 25. In 1929 the first activity was noticed on March 21 and it continued until November. New mounds were generally seen on the low prairie before they were noticed on the high prairie. The first activity in the spring is just outside of a cluster of old mounds. On April 13 two Maccabee traps were placed in an open mound and the animal caught by the next day.

Trans. Kansas Acad. Sci. 39, 1936.

7. Kansas Pocket Mouse. *Perognathus hispidus paradoxus* (Merriam). Two specimens were caught on April 3, on the low prairie near a ravine.

8. Little Gray Harvest Mouse. *Reithrodontomys albescens griseus* (Bailey). Only one specimen was caught, on April 13, in a ravine.

9. Baird White-footed Mouse. *Peromyscus maniculatus bairdi* (Hoy and Kennicott). The earliest capture record was on March 27, when one adult and one immature form were taken. Others were captured as follows: March 27, two in a ravine; April 3, one near a haystack and two on the low prairie; April 13, one on low prairie near a ravine; April 18, five in the upper end of a ravine; and on April 19, two on the low prairie. In April there seems to be a movement of this species up the slope toward the high prairie.

10. Northern White-footed Mouse. *Peromyscus leucopus noveboracensis* (Fischer). Seven specimens were captured as follows: March 27, three on the low prairie; April 3, four in a ravine near a clump of sumac bushes.

11. Ord Meadow Mouse. *Microtus pennsylvanicus pennsylvanicus* (Ord). Only two were captured, within a day of each other, one on April 12 on the low prairie, and the other on April 13 in a near-by ravine.

12. Prairie Meadow Mouse. *Microtus ochrogaster* (Wagner). Twelve were taken during the spring, as follows: April 13, one in a ravine; April 18, two in the upper end of the ravine and one on the bank; April 19, two on the low prairie, five among some sumac bushes in a ravine and two in a bunch of tall, dead grass.

13. Great Plains Jack-rabbit. *Lepus californicus melanotis* (Mearns). Only one was seen and that on June 30, in a bushy ravine.

14. Mearns Cottontail. *Sylvilagus floridanus mearnsi* (Allen). Many were seen throughout the study of the prairie fauna, always being scared out of the bushy ravines.

Spermatogenesis and Spermiogenesis of *Orchelimum nigripes* DeGeer

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I. INTRODUCTION

The sperm of *Orchelimum nigripes* were photographed by Baumgartner (1932). The photograph showed that the mature spermatozoa bore a single hook which curved outward from approximately the center of the head region. In 1935 Baumgartner and Surla described the formation of a double hook of acrosomal origin in *Amblycorypha oblongifolia* (DeGeer). The study which I have made undertakes the description of the spermatogenesis and especially the spermiogenesis of *Orchelimum nigripes* with reference to the formation of the single hook.

II. REVIEW OF LITERATURE

The literature concerned with Orthopteran cytological problems is extensive. The work, however, has largely been done on the chromosomes. The earliest account of spermiogenesis was a brief one dealing with Locustid transformation stages by Sabatier (1890). Otte (1906) gives a more detailed account of the spermiogenesis of *Locusta viridissima*. McClung (1908) published a detailed account of the behavior and morphology of the chromosomal groups of a large number of the Orthoptera. Bowen (1922) gave an account of Orthoptera acrosome formation involving the acrosome acroblast complex. Johnson (1931) published an account of the respective histories of the cytoplasmic components of the male germ cells in the Gryllidae, which includes both spermatogenesis and spermiogensis. Hareyama (1932) presented a very complete account of spermatogenesis and spermiogenesis in *Gampsocleis bürgeri* D. H. Baumgartner and Surla (1935) concerned themselves particularly with a detailed description of the spermiogenesis of *Amblycorypha oblongifolia* (DeGeer).

III. MATERIALS AND METHODS

Orchelimum nigripes is a fall species of long-horned grasshopper. It may be found throughout the southeastern part of the United States and as far west as the Rocky Mountains.

The material was collected near Lawrence, Kan., in early September, 1935. All specimens were adult. The nymphs may be collected in July and early August.

During the brief period in which living specimens were available, observations were made on living tissue. Preparations were made by spreading the entire testis on a cover glass in a drop of modified Locke's solution and sealing the cover glass over the chamber of a hollow ground slide. Some smear preparations obtained from cut follicles were also observed in the living state. The sperm were clearly seen as described by Baumgartner (1933), both in smear preparations and in the intact follicles. Other smear preparations were fixed by exposure to the fumes of a solution of corrosive sublimate in formalin and stained with Aerbach's fuchsin-methyl green.

Trans. Kansas Acad. Sci. 39, 1936.

Most of the work was done on fixed material. Flemming's and Bouin's fluids were employed as fixing agents. Most of the material was stained with Heidenhain's haematoxylin. Some preparations were stained by Flemming's triple-stain, Benda's alizarin method, Delafield-eosin and Aerbach's fuchsin-methyl green with sublimate fixation. Eosin was used as a counterstain in many of the iron haematoxylin preparations. Sections were made from three to seven microns thick.

The drawings were made with a calibrated ocular micrometer. Some were drawn at a magnification of 4,800 times, others at a magnification of 6,400 times, and one at a magnification of 4,000 times. Notation of the magnification will be found with the figures.

A. The Testis

The testis are paired structures lying among the tracheal tubes on the dorsal interior wall of the abdomen. Each organ is made up of short follicles bound together by a connective tissue investment. The cytoplasm of the connective tissue cells carries large granules of yellow or yellow-orange pigment. The pigment is clearly seen in stained sections.

The individual testicular follicles become slightly obese toward the blind end and taper toward the open end. Each follicle is composed of many cysts. The cysts occupying the blind end of the follicle contain the spermatogonia. In progression from the blind end to the open end the cysts immediately following the spermatogonial aggregations contain the primary spermatocytes; the secondary spermatocytes follow and are immediately succeeded by early spermatids which show the nebenkern in various stages of formation. The remainder of the follicle is occupied by elongated cysts bearing spermatids in various later stages of metamorphosis and by a sinus in which the mature sperm are free swimming and in which they aggregate into bundles which pass united into the vas deferens.

IV. SPERMATOGENESIS

A. The Spermatogonia

The spermatogonia of *Orchelimum nigripes* are relatively small cells which undergo a series of rapid divisions. In the prophases the accessory chromosome is evident as a dark compact mass which lies usually at the periphery of the nucleus. (Figure 1.) The spireme typically condenses from a fine granular filamentous spireme to a coarsely granular, heavy, double thread which is intricately coiled within the nucleus. McClung (1908) in speaking of the spermatogonia of *Xiphidium fasciatum* states that, "A determination of the changes experienced by the elements of this generation of cells is very difficult on account of the small size of the cells, the number of chromosomes and the tendency of the chromosomes to fuse together under the action of the fixing agents. It may be stated with reasonable certainty, however, that the number of chromosomes is the typical one for the family." [Haploid number 16-17, Diploid number, 33-(34)]. It is also interesting to note his (McClung's) statement: "That there was real similarity in the essential features of the process throughout the family I was led to believe by the study of numerous species."

The accessory chromosome behaves as a heterochromosome even in the spermatogonial divisions. Mention has already been made of its compact condition which is persistent throughout the entire condensation of the autosomal

spireme. McClung (1908) gives the following as a description of the spermatogonial metaphase, "Because of their numbers (the chromosomes) and the restrictions placed upon them by the size of the cell, they form an almost solid mass of chromatin in the equatorial plate during metaphase." The spermatogonial metaphase plate of *O. nigripes* is also a compact mass of chromatin. The accessory chromosome is very prominent as a "V"-shaped structure lying at the periphery of the spindle with its vertex embedded in the chromatin mass and two limbs extended outward. (Figure 2.)

In connection with a discussion of the spermatogonial anaphase it is again pertinent to quote McClung (1908): "Of the thirty-three elements the accessory chromosome is by far the most prominent in all stages of mitosis. The insertion of the fiber is median, and the halves of the dividing chromosome go to the poles of the spindle as 'U'-shaped loops. While the limbs of the 'U' are generally parallel, they are sometimes widely separated, thus forming a 'V'-shaped figure. Because of their length these parts of the accessory chromosome remain for some time with their ends in the region of the equatorial plate, but they are gradually withdrawn into the general mass of chromatin at the ends of the spindle." It is clearly seen in *O. nigripes* that the behavior of the accessory at anaphase and telophase is very similar to that described by McClung for *Xiphidium fasciatum*. (Fig. 3.) It is interesting to note that the chromatin material of autosomal origin is in the process of diffusion in preparation for the interphase nucleus, while the accessory chromosome is still extended over the spindle.

B. Primary Spermatocytes

The growth stages which follow the final spermatogonial division embrace phenomena which are characteristic of these phases as described by many authors. The autosomal spireme may be seen to condense from a leptotene thread into pachytene. The spireme appears to be double throughout the condensation. (Fig. 4, Leptotene spireme.) (Fig. 5, Pachytene spireme.) Coincident enlargement of the nucleus with change of the nuclear-cytoplasmic ratio is apparent. The primary spermatocyte, then, has an extremely large nucleus with only a narrow rim of cytoplasm. Within the cytoplasm, the dictyosomal mass may be clearly seen as an oval, moderately staining body with two chromophilic curved bars forming an incomplete oval within. This body at all times remains closely associated with the nuclear wall.

The behavior of the accessory chromosome during the growth period from the final spermatogonium to the primary spermatocyte prophase is distinctly that of a heterochromosome. The accessor forms a spireme independent of the euchromosomal spireme. This spireme is very compact and chromophilic in contrast with the diffuse, irregular, "fuzzy" euchromosomal spireme. The accessory spireme gradually undergoes a condensation which carries it through a lengthy series of variable forms until it reaches its final shape, which is a loop with two projecting ends which frequently lie close together. (Figure 6-a-h.) The remainder of the nucleus at this time shows the typical autosomal synaptic figures. (Figure 7.) Otte (1906) figured this independent behavior of the accessory spireme but postulated that the accessory chromosome divided during the primary spermatocyte (synaptic) division. McClung's description of the completely formed accessory chromosome in *Xiphi-*

dium might easily be substituted for the description of the accessory in *Orchelimum*. It is as follows: "This double thread may lie straight but more commonly is convoluted with the free ends in approximation." I found ample evidence in the condensing spireme to indicate that it is a double thread. (Figure 6, a, b, f.) The condensation is described by McClung. "While it (the accessory) forms a thread this is always denser and more compact than the general spireme. The long, slender, much coiled thread of the spireme gradually shortens, thickens and uncoils, the result being to produce generally a thread bent upon itself at or near the middle. There is no fixed type form and almost any shape that a flexible thread may take is represented."

In the early anaphase of the primary spermatocyte division the accessory chromosome may be seen in several positions in relation to the spindle. It was my observation that it usually remained a loop or bent thread and always occupies a position well to the outside of the spindle. (Figures 11 and 12.) In some cells it is clearly seen to be completely alienated from the other chromatic elements. McClung describes the behavior of the accessory at this stage as follows: ". . . before the metaphase is reached the rod has almost invariably become almost straight, and never shows the 'U' shape of the early prophase." And, ". . . as it approaches the metaphase, it takes on the boomerang form described in my earlier paper." In a few cells at late metaphase or early anaphase I am able to observe a "boomerang" shape. (Figure 10.) I would, however, be unable to say that this condition is constant. (Figures 8, 9, and 10.)

C. Secondary Spermatocytes

The accessory chromosome is frequently observed to retain its shape through nearly the complete reorganization of the interphase nucleus. It finally, however, condenses into an amorphous chromophilic mass which is just within the nuclear wall. The secondary spermatocyte has a very small nucleus and relatively an enormous amount of cytoplasm. (Figures 13 and 14.) From the cell which contains the accessory is derived a telophasic figure almost identical with that seen in the spermatogonial telophase with the exception that the secondary spermatocyte figure consists of half the amount of chromatin. (Figure 15.) The telophasic figure of the cell which does not contain the accessory shows only equal divisioñ of the autosomal chromatin. (Figure 16.)

V. THE SPERMIOGENIC CHANGES

A. Spermatic Transformation in O. nigripes

While the spermatogenesis described above has shown nothing strikingly dissimilar to other descriptions of Locustid spermatogenesis, the phenomena encountered in the spermiogenesis of *Ochelimum nigripes* are distinctly different and more complicated.

The nucleus of the young spermatid shows a very diffuse arrangement of chromatin material. The larger aggregates are seen near the periphery. The dictyosomal mass which is yet to be seen in close connection with the nucleus soon becomes oriented into a clear vesicle with a darker staining periphery which lies intimate with the nucleus a little to the right of the lower pole of the cell. Polarity at this time is determined by the aggregation of chrondriosomes in the region which will be traversed by the axial filament. (Figure

17.) The spermatid nucleus is somewhat larger than the secondary spermatocyte nucleus and thé accessory chromosome is still evident in half the cells as a compact chromaphilic mass lying near the nuclear membrane. (Figure 18.)

The nebenkern of *O. nigripes* is never observed to possess the chromophilic properties which Baumgartner and Surla (1935) figured for *Amblycorypha oblongifolia*. The early nebenkern appears as a homogenous moderately chromophilic mass. This mass soon orients itself about the axial filament and condenses in such a way that a contracted mass surrounds the filament at its origin and at its exit from the nebenkern body while the central portion, lying within the nebenkern, is surrounded by a vocuolated sphere. This whole figure, then, is enclosed within a clear sphere which is slightly larger than the original nebenkern aggregate. (Figure 19.) Meanwhile the acroblastic vesicle is seen to progress around the side of the nucleus and enlarge as it moves. The nebenkern soon begins its elongation, which is accompanied by further internal vacuolation, with the result that soon the nebenkern appears only as an oval vesicle traversed by threads of moderately chromophilic material. These threads have a constant arrangement or pattern. The central thread is the axial filament surrounded by a small deposit of nebenkern material. This axial division apparently bisects the ellipse (in section) and divides it into a right and left ellipse each of which again is bisected by a thread of condensed nebenkern substance. (Figure 20.) This complex body, then, elongates as the axial filament extends in length. (Figure 21.) A cross section of the nebenkern shows clearly that the axial division is a partition which divides the nebenkern into two bodies of equal volume, while the two other divisions are only apparent in longitudinal section and in cross section are discovered to be axial threads of the two lateral bodies and possess only terminal attachments. (Figure 22.)

The acroblast eventually reaches the apex of the cell. The chromophilic periphery thickens and becomes more and more prominent while the acroblast is in progress. (Figures 19-27.) Soon after the establishment of the acroblast at the apex it begins to flatten out over the nucleus and is then seen as a densely staining hemisphere. (Figure 28.) While the acroblast is still in the process of migration the dark staining periphery often shows a definite cleft which divides it into halves. It is interesting to note this in view of the fact that a later stage shows a definitely double acroblast. (Figure 26.)

The nucleus during the above stages becomes gradually more and more diffuse. There always remains, however, a relatively small condensed mass which may curve with the nuclear membrane at the periphery or keep a spherical shape near the center of the nucleus. The remaining cromatin diffuses by vacuolation typically forming a central vacuole which gradually enlarges by the coalescence of peripherally placed vacuoles. (Figures 23-26.) Eventually the nucleus becomes homogenous and shows only a slight affinity for stain. The one spherical condensed mass with a few strands of cromatin material extending from it remains for a while and usually lies in an irregularly shaped area which takes a slightly heavier stain than the remainder of the nucleus. This mass gradually migrates to the periphery of the cell and upward until it comes to lie just beneath the acroblast. (Figure 29.) For a brief period the nuclear material appears only as two condensed masses on either side of the flattening acroblast. (Figures 30 a and b.) Eventually a complete fusion of chromatin and acroblastic material is effected and the fused mass lies

completely covering the apical end of the slightly elongated homogeneous nuclear body proper. The two lateral edges of the apical chromophilic mass show slight swellings which represent the regions of fusion of the nuclear elements. The center of the mass soon begins to show a pointed anterior projection which marks the apex of the entire structure. (Figures 31 a-b-c.)

The changes which take place subsequently are principally inclusive under two general types of change, *i. e.*, rearrangement and elongation. The spermatid in the remainder of its metamorphosis is constantly elongating as a whole and its parts also extend. In general, it may be said that acrosomal derivities elongate by forward extension and nuclear material elongates by backward extension.

The completely fused chromatin-acrosome complex notably enlarges and thickens just before extension. (Figure 32.) Considering this mass as a thick band lying across the upper surface of a sphere it is possible to apply the terms lateral, dorsal, and ventral. These designations are arbitrary and are introduced only as a mechanical convenience in describing the subsequent changes. The spermatid soon becomes flattened and I am conceiving this flattening as due to an approximation of the dorsal and ventral surfaces. The spermatid is then possessed of lateral symmetry, the nuclear and acrosomal figures being of equal volume and similar design on either side of a line arbitrarily drawn continuous with the axial filament. E. B. Wilson (1928), in describing flattened sperm, speaks of a view taken through the lesser diameter as a lateral view and a view through the greater diameter as a "face" view. If the sperm head curves or is bent the lesser curvature represents the "face" and the greater curvature represents the dorsal surface or "back." I will use these points of reference similarly in the following description.

The nuclear-acrosomal complex shows in early stages dorsal-ventral compression. The lateral enlargements which in general may be conceived as containing material of nuclear origin commence an elongation downward and slightly forward in the elongating "nuclear body." (Figures 33-34.) The term "nuclear body" may here require qualification. It is perfectly obvious that the spherical spermatid is the naked nucleus of the secondary spermatocyte. The cytoplasm of the early spermatid followed the nebenkern in migration down the axial filament. "Blebs" are seen in the process of migration until the sperm adult is released into the sinus at the open end of the tubule. The diffusion of the chromatin has been described above. Eventually all the chromatic material which remains fuses with the acroblast, leaving the nucleus a moderately staining homogeneous body or "nuclear body." Coincident with the projection of the lateral "arms" a slight backward extension may be noted which anteriorly is marked by a slight constriction in the acroblast and posteriorly for a very short distance lies over a fairly clear vesicle of "nuclear body" material. (Figure 35.)

Very soon a fusion of the lateral "arm" extension in the center of the cell occurs. A "face" or ventral view of the spermatid at this stage shows a central mass which soon becomes granular and an anterior inverted "U" which stains heavily in all parts except the apical pointed projection. The inverted "U" shows a slight constriction which approximates the arms. The central mass bears a threadlike projection through the "nuclear body" which is continuous with the axial filament. (Figures 36 a and b.)

The stages immediately following are characterized only by a gradual

elongation of all parts with a simultaneous separation of the central mass from the "arms" of the inverted "U." (Figures 37-38.) The spermatid is then divisible into two regions, the lower region consisting of chromatic and achromatic nuclear material and the upper region consisting of acroblastic material. Rearrangement is then practically complete. The various shapes which are assumed by the spermatid during the following phases of metamorphosis are evolved chiefly through the elongation of preëxisting parts and changes in the staining affinity of these parts.

For some time during the process of elongation the nuclear material may in some spermatids be seen to maintain a slender granular thread attachment to the acroblastic "cap." (Figures 39 a and b.) Finally when the two structures become completely alienated the ends of the "U" arms round up into very distinctly chromophilic spheres. At the same time the apical portion of the acroblast loses its affinity for stain except for a slender thread of material which divides the acroblast into equal halves. The proximal and distal ends of this thread show triangular and semilunar thickenings of chromophilic material, respectively. The distal semilunar area soon becomes divided in the middle and the halves cap the right and left columns of the acroblast. The nucleus meanwhile is assuming an ovoid shape (figure 40), and while it maintains its connection with the origin of the axial filament it is only distinctly chromophilic in its anterior position. (Figures 41 a and b and 42 a and b.)

The acroblastic columns elongate considerably and become distinctly narrower, resting on the chromophilic spheres which are beginning to show slender threadlike posterior-lateral extensions. These in the course of subsequent elongation deplete the sphere gradually until it disappears. The semilunar dicromatic "caps" on the acroblast columns very soon become sound and the double apex becomes flattened and wider and turns forward. The flexure is acute.

Two clear vesicles are evident within the sperm head at this time. One lies between the nucleus and the acroblast and is roughly "horseshoe" shaped while the other is an asymmetrical sphere lying dorsal to the nucleus. The greatest elongation in the spermatid at this time is seen in the posterior extension of the "nuclear body." It becomes quite slender and is traversed by the finely granular thread which connects the nucleus with the origin of the axial filament. (Figures 43 a and b.)

The spermatid now is a broad flat structure with seemingly a variable amount of achromatic material about the elongated nucleus. The spermatid usually is straight but may show an obtuse flexure at the juncture of the acroblast and nucleus. The clear vesicle lying posterior to the nucleus seems to imbibe fluid and swell to such an extent that the posterio-lateral extensions lie almost at right angles with the erect acroblast columns. (Figures 44 a and b.)

The vesicle behind the nucleus shrinks considerably and the acroblastic extensions are separated from the nuclear material only by a thin rim of clear substance. In the "face" view the spermatid acroblast takes the form of an "H" with the lines above the cross bar approximated and the lines below the cross bar spread. It is not evenly chromophilic. It takes the stain deeply only in the posterior extensions. Two chromophilic spheres are seen at the apex of the figure. The nucleus is seen in the side view to be taking a distinctly frontal position. "Blebs" of clear material which may possibly

be interpreted as acroblast remnants are seen to be passing over the nucleus and onto the axial filament. (Figures 45 a and b, and 46 a and b.)

The sperm head becomes progressively chromophobic (figures 47-48), until the adult sperm is largely light staining. The nucleus is a slender dark ventral band which extends from the origin of the axial filament to a point just slightly posterior to the base of the apical projection of the acrosome. The posterio-lateral acroblastic extensions fuse on the dorsal line and form a "hood" of chromophilic material over the tip of the sperm head. The single hook is a posterior extension from this "hood" and curves with the sperm head for a short distance and then turns outward abruptly. In the adult spermatozoon the hook extends about half the length of the sperm head. It has a chromophilic core formed of the elongated posterio-lateral processes and is surrounded by a close fitting "jacket" of chromophobic material. (Figure 49.)

VI. THE SPERM BUNDLE

The adult free-swimming spermatozoons when released into the sinus in the open end of the testicular follicle line up with their heads literally stuck into the tubule wall. They seem to extract from the wall a protoplasmic substance which binds them into bundles. Approximately twenty sperm heads are bound in each bundle.

Within the bundle the sperm all face the same direction. They lie so close together that the projecting hook of each lies under the head of the one immediately behind.

The sperm tails of *O. nigripes* are relatively short. They are only about twice as long as the sperm heads.

The bundles may be secured in large numbers from the vas deferens. They are barely visible to the naked eye.

VII. DISCUSSION

The various components of the transforming spermatid have been extensively studied and controversy exists over the respective origin and behavior of each. An excellent review of such literature is given by Baumgartner and Surla (1935).

Much work has been done on the spermatid transformations of the Hemiptera, Lepidoptera, etc., but I shall consider in the following discussion only the literature concerned with Orthopteran spermatid transformations. For purposes of comparison of the spermatid transformation stages of *O. nigripes* with those previously described, I will briefly summarize the stages as enumerated by the following authors: Sabatier (1890 on several species of Tettigoniidae), Davis (1908 on Acridiidate and Locustidae), Otte (1907 on Locusta), Johnson (1931 on Gryllidae), Baumgartner and Surla (1931 on Tettigoniidae) and Hareyama (1932 on Locustidae).

Sabatier (1890) was one of the first to observe the nebenkern in the Tettigoniid spermatid. He believed that this structure arose from the "vesicule protoplasmique" of unknown origin and fate. He derives the acrosome from the "vesicules nuclearises" which arise from the direct metamorphosis of the nucleus. These vesicles fuse and are gradually reduced to three; namely, a median one small and projecting, and two lateral ones which elongate and

differentiate to form the two branches or hooks of the anchor which constitutes the cephalic hood. (*Coiffe cephalique.*)

Otte (1907) describes the nebenkern in Locusta as arising from the fusion of chondriosomes which aggregate near the interzonal fibers. The nebenkern differentiates into an inner chromophilic core and an outer chromophobic part and migrates down the axial filament about which it forms a sheath. The acrosome he describes as being formed from the idiosome which had its origin in the metamorphosis of the interzonal fibers and a portion of the mitochondria. Otte describes the centrioles as exceedingly small granules which orient themselves from a peripheral position to a proximal and distal one. The proximal centriole lies at the nuclear membrane and the distal one at the cell wall. The intracellular axial filament extends between the centrioles and the extracellular axial filament extends outward from the distal centriole. These centrioles divide so as to form four centrioles. The two inner ones migrate into the nucleus and the two outer centrioles elongate and take part in the formation of the middle piece.

Davis (1908) working chiefly on Steiroxys does not identify the nebenkern and does not trace the behavior of any structure which might correspond to it. He describes the acrosome as arising from a rounded structure which he calls "Nebenkern." He traces the transformation of this structure into the anchor-shaped acrosome. He does not describe the casting off of any substance from the acrosome complex. Davis first observes the centrioles in the elongating spermatids. He describes the division of the proximal and distal centrioles.

Johnson (1931) did his work chiefly on *Oecanthus nigricornis* Walker. He was able to trace the centrioles in unbroken continuity from dividing spermatogonia to late spermatids. In the spermatogonium they are short rods in the early auxocytes "V" shaped representing a tetrad of four rods, one of which passes into each spermatid. In the spermatid the centriole rod divides into proximal and distal components of spherical form. A derivitive which passes to the outer end of the axial sheath is budded from the distal centriole. Two centrioles remain in the middle-piece.

The nebenkern (derived from chondriosomes) elongates by the release of successive tiers of swelling, chromophobic vacuoles from a chromophilic central core.

The acrosome is elaborated from the acroblast which was originally formed by the fusion of dictyosomes. The acroblast later is sloughed off in the tail region and fragments into dictyosomes.

In the spermatid the acroblast consists of two portions, the smaller of which is more chromophilic and preserved with difficulty. The chromophilic figure from the front (face) view has somewhat the form of an "H" with a chromophilic mass closing the top and two spherical masses at either end of the cross bar. In side view it appears as two beads spaced on an upright wire.

Baumgartner and Surla (1935) working with *Amblycorypha oblongifolia* (DeGeer) describe the spermatid transformation in considerable detail. Briefly, their conclusions are as follows:

The nuclear material of the early spermatid differentiates into a basichromotin substance and an oxiphilic substance. The solid, deeply staining fusiform sperm nucleus is formed from the basichromatin.

The mitochondria fuses and condenses into a spherical nebenkern which

later differentiates into an inner chromophilic core and as outer chromophobic part, surrounded by a membrane. "Later it comes to lie on or below the axial filament, elongates with this structure, and finally forms a covering around the flagellum."

The dictyosomes fuse and the mass resulting from the fusion comes to lie against the nuclear membrane near the nebenkern. "From it a visicle is differentiated which increases rapidly in size to form the acroblast. The acroblast migrates around the nucleus, and, after the formation of the acrosome complex in close association with it, it is finally cast off into the cytoplasm. The acrosome complex, which consists of a vesicle containing a deeply staining granule, becomes the definitive acrosome, having the shape of an inverted 'V.' "

"The spherical centriole divides into proximal and distal parts. From the distal centriole a derivitive arises, which migrates caudad and finally disappears from view in the last stages of the transformation. Later the proximal and distal centrioles divide. The four centrioles resulting from this division participate in the formation of the middle piece. The axial filament apparently originates from the central bodies, but it has not been determined whether or not it originates from the distal centriole. From it the comparatively short flagellum of the mature spermatozoon is formed."

"The spermatozoon consists of a large inverted 'V' shaped acrosome, which strains lightly or not at all; a solid, deeply staining, fusiform nucleus, to the posterior end of which is attached the scarcely distinguishable compact middle piece; and a short flagellum, which measures approximately twice that of the head."

Harcyama (1932) gives a very extensive account of both the spermatogenesis and spermiogenesis of *Gampsocleis bürgeri* D. H. The nebenkern of mitochondrial origin is described as dividing into halves which lie on either side of the axial filament and twist separately for a short time. They soon become intimate with the axial filament and elongate with this structure.

Harcyama describes the formation of an exceedingly complicated acrosome which has its origin in the Golgi apparatus plus the idiosome. He figures the dictyosomal mass much as it is seen in *O. nigripes*. The transformation of this body, then, into the acroblastic vesicle is also very similar to that seen in *O. nigripes*. The acroblast is at first a clear vesicle with a darker periphery. It gradually condenses into a heavily staining body which lies in the apical position. The hemisphere becomes imperfect in shape and two "arms" grow down on either side of the elongating nucleus. Various figures are notable as a result of changes in the staining affinity of parts of the acroblast. Many of the figures distinctly resemble analogous stages in the spermatid transformation stages of *O. nigripes*. The ultimate acrosome in *G. bürgeri* is "V" shaped with the "limbs" of the "V" widely separated. The acrosome of the adult sperm takes only a moderately heavy stain. The nucleus remains diffuse throughout the entire process and never shows the heavy central condensation that is seen in *O. nigripes*.

VIII. ADDITIONAL NOTES

A. The Centrioles

I am unable to follow the centrioles throughout the spermatid transformation stages.

In the early spermatid the centrioles lie divided close to the nucleus. (Figure 18.) In a few cases I am able to see them (still double) at the origin of the filament. In many of the later spermatids, paired oval bodies were observed in the region of the origin of the axial filament, but I am unable to say that they are centrioles. The axial filament seems always to originate between them. (Figures 38, 43, 45. Harcyama (1932) describes and figures the migration of two centrioles into the nuclear material itself. From these, filaments grow and unite with the centrioles which lie outside the nucleus and give rise to the axial filament. It seems logical that since in *O. nigripes* a thread is constantly seen to extend from the nuclear condensation to the origin of the axial filament that similar behavior of the centrioles might be traced for that species, but I am unable to observe any such phenomenon.

B. The Dictyosomal Mass

The dictyosomal mass is definitely identified by its staining reaction. In staining with iron haematoxylin after fixation with Gatenby's modification of Flemming's fluid without acetic these bodies take a black stain which is specific for the fatty elements found in connection with the dictyosomes (Golgi apparatus). These cytoplasmic inclusions are not seen in sections fixed in Flemming's unmodified solution.

C. Sperm Topography

I am unable to distinguish any definite middle piece in the sperm of *O. nigripes*. Smear preparations of the adult sperm stained with Auerbach's fuchsin and methyl green definitely show thc parts described above as nuclear to take the methyl green stain. The parts described above as having a cytoplasmic origin definitely take the fuchsin stain. The acrosome, hook and axial filament are stained red by this method.

IX. SUMMARY

1. The spermatogonia are relatively small cells. The accessory chromosome is evident as a peripheral darkly staining body in the prophases, a "U" or "V" shaped large chromosome at the periphery of the spindle and as a lag chromosome in the anaphases and telophases.

2. The growth stages which follow the final spermatogonial division show a condensation of the leptotine thread into the pachytene thread. Meanwhile the accessery chromosome undergoes an independent diffusion (or unraveling) and condensation.

3. The primary spermatocyte is the largest cell of the series. In the prophases the typical autosomal synaptic figures are clearly seen. The accessory chromosome is a densely staining bent thread with the ends of the thread in approximation. The dictyosomal mass lies just outside the nucleus and appears as an ovoid homogeneous mass with an incomplete oval of chromophilic substance within.

4. The accessory chromosome passes undivided to one pole in the primary spermatocyte anaphases and retains its specific shape through the telophases and often through the complete reorganization of the interphase nucleus.

5. The secondary spermatocytes are much smaller cells. Half of them contain the accessory chromosome and half of them do not. The accessory behaves again as a lag chromosome in the secondary spermatocyte division.

6. The early spermatid shows an aggregation of the mitochondria into a nebenkern. The dictyosomal mass soon becomes differentiated into the acroblastic vesicle which lies close to the nuclear membrane.

7. The acroblastic vesicle migrates to the apex of the nucleus and the nebenkern, now showing a definite pattern, surrounds the axial filament.

8. The cytoplasm is gradually sloughed by way of the axial filament. The acroblast becomes a darkly staining hemisphere over the top of the naked nucleus. The chromatin of the nucleus gradually condenses into an irregular sphere.

9. The chromatin sphere of the nucleus migrates to the apex and fuses with the acroblast which has now spread over the surface of the nucleus.

10. Lateral extensions grow into the nuclear body from the acroblast. These fuse in the midline. The mass resulting from their fusion is the sperm nucleus.

11. The "U" shaped acroblast elongates considerably, becomes slender and chromophobic. It is divided into two columns. Each column bears a chromophilic spherical aggregate at its distal tip. Two chromatic spheres lie at the base of the acroblast and send out lateral extensions.

12. The chromatic spheres are eventually dissipated by the elongation of the posterio-lateral extensions. The nucleus elongates and maintains connection with the axial filament. It is densely chromophilic only at its anterior end.

13. The slightly curved adult spermatozoon is formed by continued elongation of all parts coincident with a conversion of the greater part of chromophilic material into chromophobic material.

14. The single hook lies on the dorsal side and remains chromophilic in part. It is formed by the fusion of the acroblastic posterio-lateral extensions. It is single by fusion.

15. The acrosome when completed is a long flat process spread anteriorly and bearing two chromophilic spheres.

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EXPLANATION OF FIGURES

PLATE I

FIGURE

1. Spermatogonial prophase. The accessory chromosome is seen at the periphery of the nucleus.
2. Spermatogonial metaphase showing compact equatorial plate and accessory at edge of spindle.
3. Spermatogonial telophase showing the accessory division and lag position.
4. Leptotene spireme of very early primary spermatocyte. Dictyosomal mass is evident just ouside the nucleus.
5. Pachytene spireme of early primary spermatocyte. The accessory spireme is in a late stage of condensation.
6. The accessory spireme in various stages of condensation.
7. Late prophase of primary spermatocyte. The autosomal synaptic figures are in evidence. The accessory chromosome is completely formed.

8, 9, 10. Metaphases of primary spermatocytes showing various positions and shapes of the accessory chromosome.

Magnification: 1-10-x4800.

PLATE I

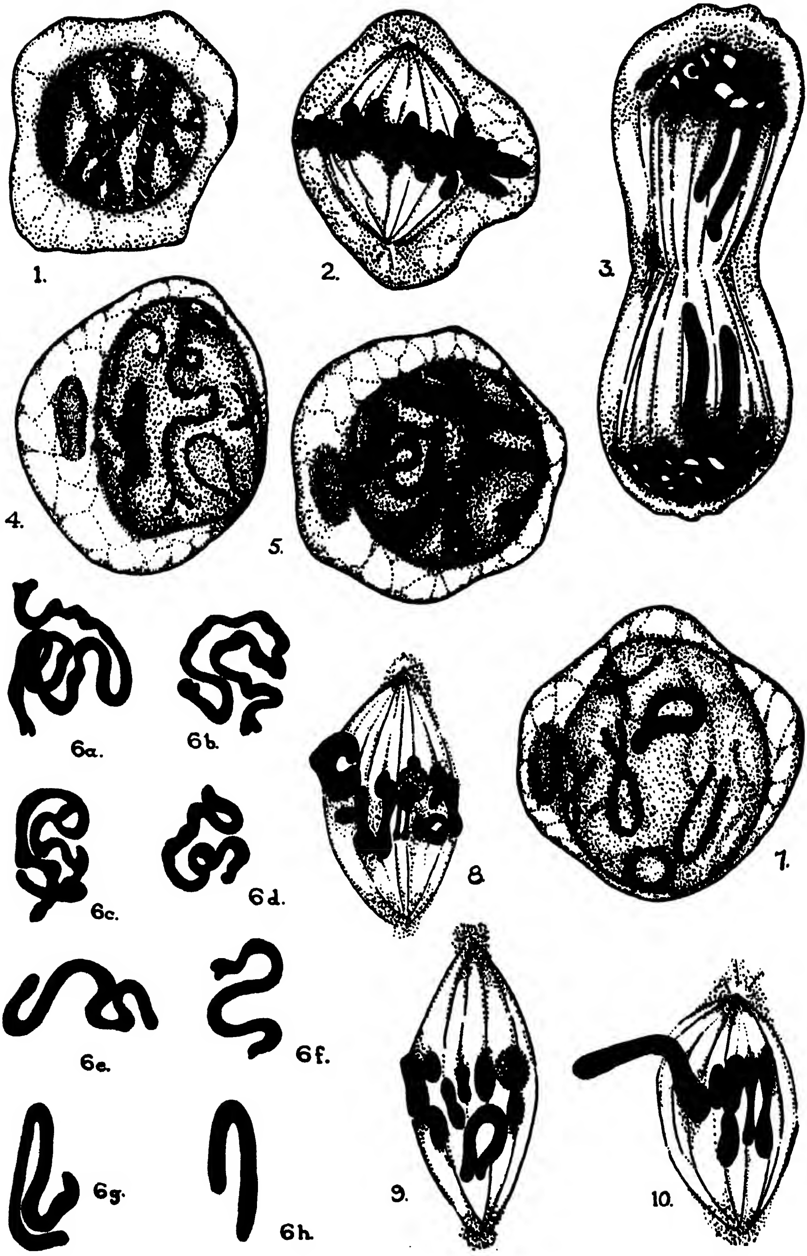


PLATE II

FIGURE

11. Early anaphase of primary spermatocyte.
12. Telophase of primary spermatocyte showing accessory chromosome undivided at one pole.
13. Secondary spermatocyte prophase. Cell without the accessory chromosome.
14. Secondary spermatocyte prophase. Cell with accessory chromosome.
15. Secondary spermatocyte telophase. The accessory is shown as a lag chromosome.
16. Secondary spermatocyte telophase showing the chromatin distribution without the accessory chromosome.
17. Early spermatid. The nebenkern is in evidence in the cytoplasm. Two centrioles are present. The nucleus is without the accessory chromosome.
18. The same as figure 17, except that the nucleus bears the accessory chromosome.
19. Later spermatid. The nebenkern shows vesiculation. The acroblast is present at the edge of the nucleus.
20. Spermatid showing the completely formed nebenkern. The acroblast is in the process of migration and the chromatin material of the nucleus is diffusing.
21. Spermatid showing the nebenkern in an early stage of migration.
22. Cross section of nebenkern.

Magnification: 11-18 $\times$ 4800
19-22 $\times$ 6400

PLATE II

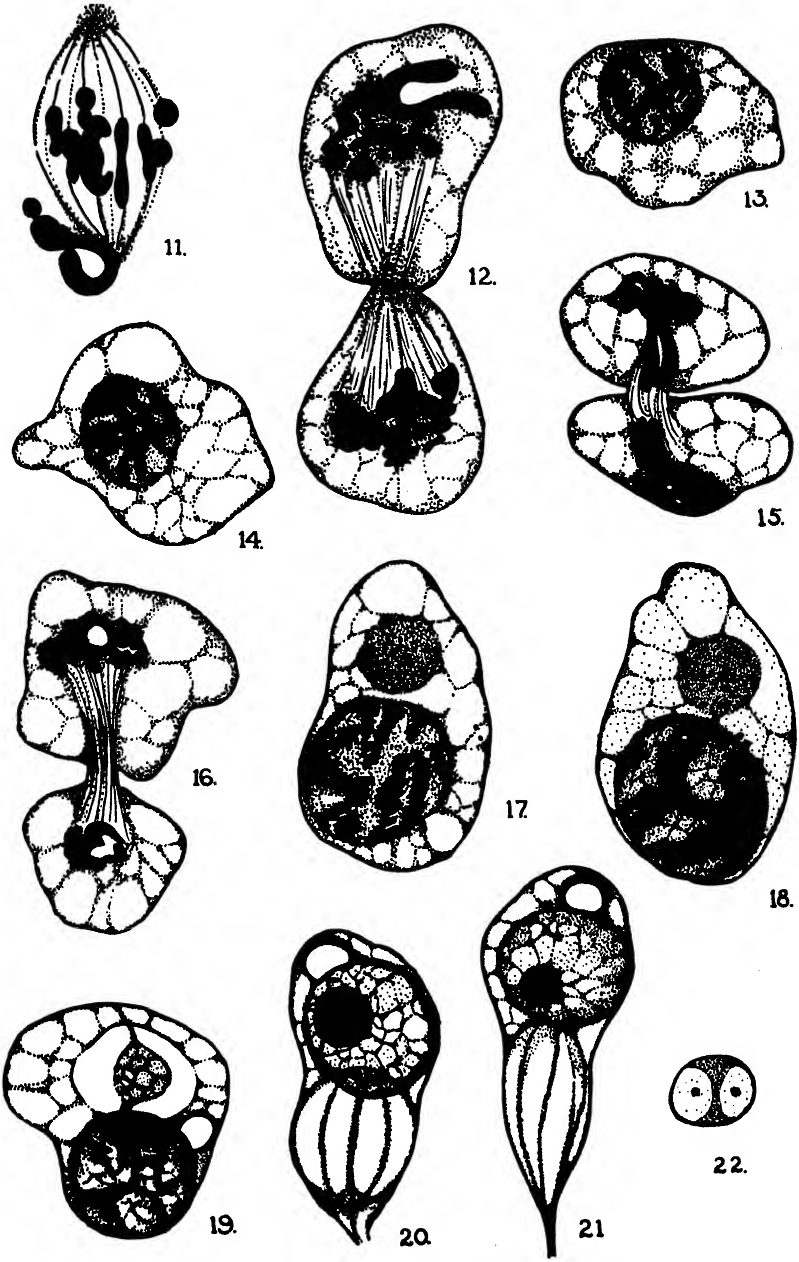


PLATE III

FIGURE

23. Later stage in the migration of the nebenkern down the axial filament.
24. Spermatid showing very prominent acroblast in the process of migration. The very dark periphery is contrasted with the clear central portion.

25, 26. Spermatids. 26 shows a division of the chromatic periphery of the acroblast. Both show stages in the diffusion of nuclear chromatin.

27, 28, 29. Stages in the condensation of the acroblast. The nuclear material is condensed into one compact sphere; 29 figures its migration to the periphery.

30 a and b. Face and lateral views of spermatid heads with fused nuclear and acroblastic mass lying over diffuse nucleus.

31 a, b, c. Face, lateral and cross sectional views of spermatid head showing some elongation. The nucleus-acroblast complex is showing some differentiation.

32, 33. Semipolar views showing the first stages of the elongation of the lateral "arms."

34, 35. Later stages in the migration of the lateral arms.

36 a and b. Face and lateral views of spermatid head showing central nuclear aggregate effected by the fusion of the lateral arms. Tip of acroblast is becoming chromophobic.

Magnification: 23-36 $\times$ 6400.

PLATE III

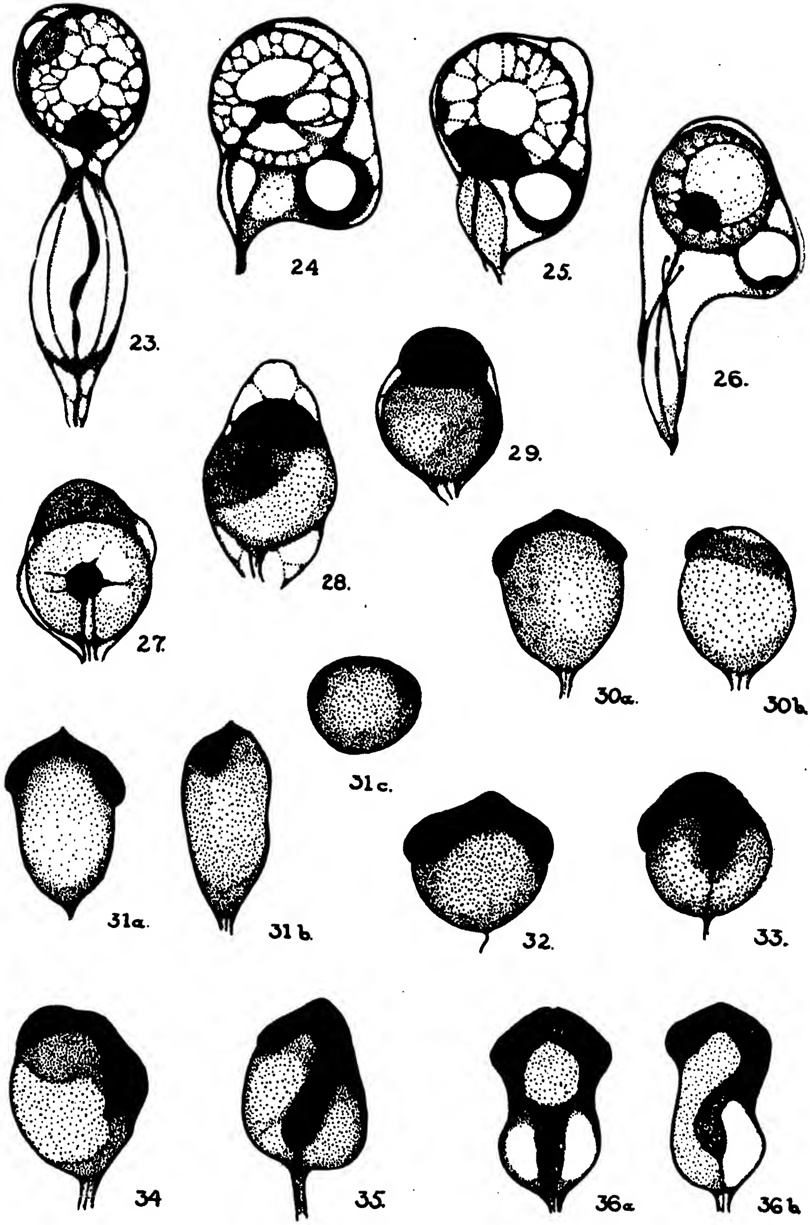


PLATE IV

FIGURE

37 a and b. Face and lateral views of spermatid head showing more elongation and partial alienation of nuclear material from acroblastic material.

38 a and b. Face and lateral views of elongating spermatid head. Changes in staining affinity of various parts are noted.

39 a and b, 40. Stages in the diffusion of the nuclear material. Notable elongation.

41 a and b. Reduction of chromophilic material in the acroblast. The nucleus and acroblast tip also show regional affinity for stain.

42 a and b. Complicated acroblastic figure in face and lateral view. Considerable elongation is noted and the head is seen to be differentiating into definite vesicles.

43 a and b. Illustrating the extension of the posterio-lateral arms. The acroblast is definitely divided into two columns.

Magnification: 37-43 $\times$ 6400.

PLATE IV

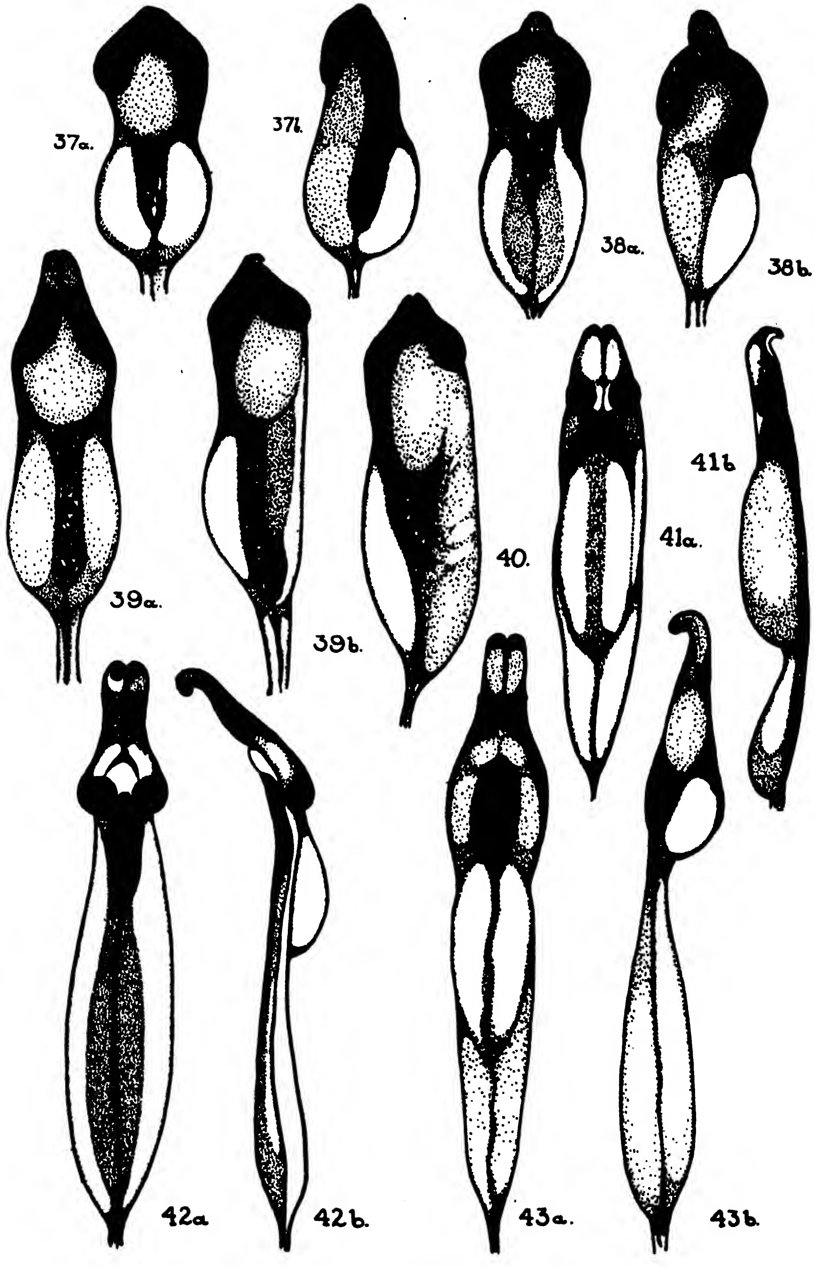


PLATE V

FIGURES

44 a and b. Elongated spermatid head showing extreme elongation of the acroblast and enlargement of the postnuclear vesicle.

45 a and b. Face and lateral views of spermatid head showing further extension of posterio-lateral arms.

46 a and b. Lateral and cross-sectional views of spermatid head just before the elongation of the nucleus.

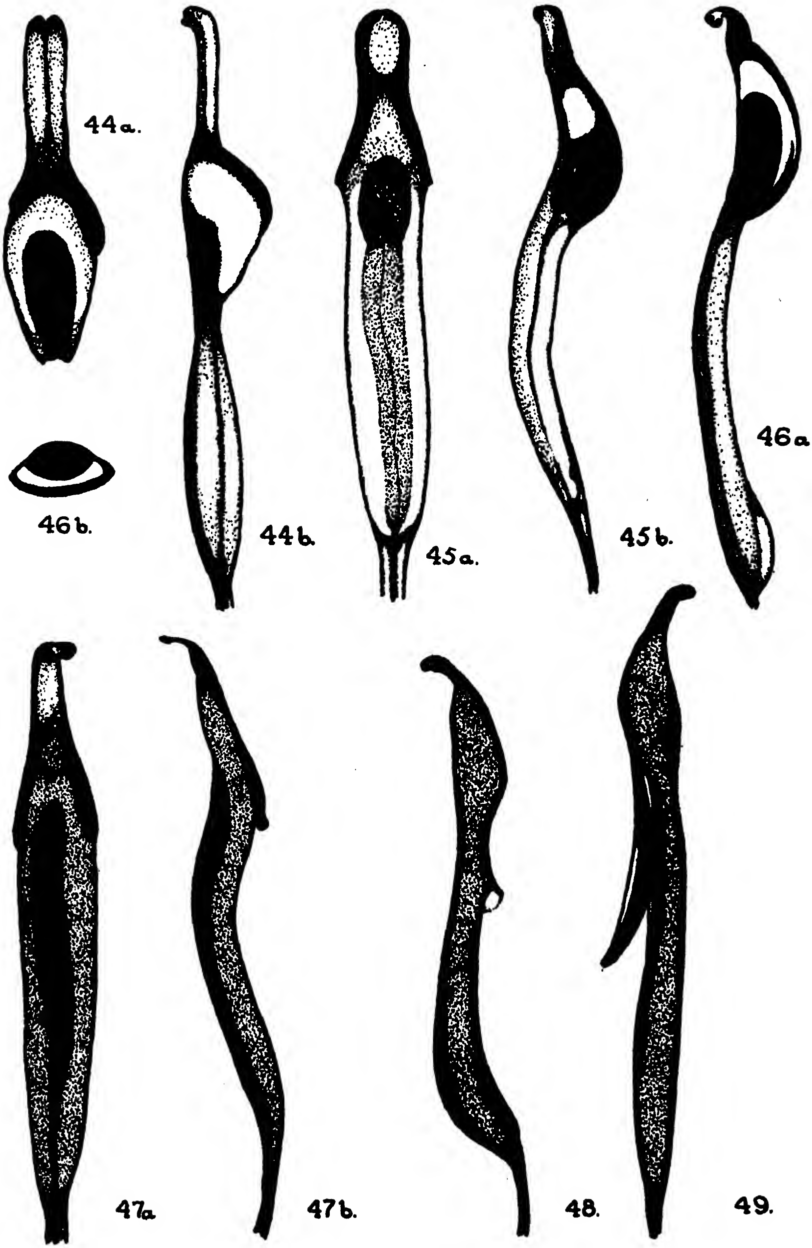
47 a and b. Elongation of the nucleus in face and lateral view. Reduction in chromophilic material is noted.

48. Showing still further reduction in chromophilic material and extension of posterio-lateral processes.

49. Mature spermatozoon showing long hook curved outward. The hook is double as a result of the fusion of the posterio-lateral processes.

Magnification: 44-49 $\times$ 6400.

PLATE V



The Effect of Antuitrin Growth[1] Injections on Female Albino Rats Fed a Diet Deficient in Vitamin A.[2]

E. J. WIMMER and J. C. AYERS, Kansas State College, Manhattan, Kan.

Since normal growth is impossible in the absence of certain vitamins, and since the absence of definite hormones results in a similar lack of growth, it was thought for some time that a relationship might exist between them. This idea became strengthened when Szent-Györgyi (*6*) reported in 1932 the presence of vitamin C (ascorbic acid) in the adrenal glands. In 1932 the senior author began a series of experiments in injecting growth-promoting extracts of the anterior pituitary gland into white rats fed a diet deficient in vitamins necessary to normal growth. The extract was prepared from fresh beef pituitary glands according to the method of Evans, Cornish and Simpson (*4*), daily injections of 1 cc. of the extract were made subcutaneously. It was finally decided that injections of the growth-promoting extract showed most promise in rats deprived of vitamin A. In one group of rats injections were begun on the twenty-eighth day when the rats were placed on a Sherman A-free diet. In another group of rats injections were not made until the rats began to lose weight, while in a third group injections were not begun until signs of xerophthalmia became evident. The first group injected from the twenty-eighth day showed a greater gain in weight over control rats which were on the A-free diet and were not injected. Rats injected as soon as the body weight began to drop showed an immediate resumption in growth, while controls which were not injected continued to lose weight. Animals injected when xerophthalmia became apparent showed a slight gain in weight and a temporary improvement in the eye condition. Since an insufficient number of animals were placed upon the diets and since the extract as obtained, although causing marked acceleration in growth in animals fed a normal diet, was believed to contain much extraneous matter, it was decided to confirm these findings by further experiments with a purer extract.

An extract of the anterior pituitary gland, containing the growth-promoting principles and containing negligible amounts of thyrotropic and oestrogenic substances, was made available in 1935 by Parke, Davis & Co., under the name Antuitrin-G (now Antuitrin Growth). This extract proved to be most suited to our needs.

The albino rats used in these experiments were of the second generation of brother and sister matings from selected breeding stock. The matings took place in small breeding cages and the males were removed as soon as the females were heavy. The experimental animals and the controls were kept in especially constructed cages floored with half-inch wire mesh. By these methods all consumption of feces was prevented and a maximum rate of depletion was secured.

The vaginal smear as described by Evans and Bishop (*3*), Macy *et al.* (*5*),

Trans. Kansas Acad. Sci. 39, 1936.

1. Antuitrin Growth (Formerly Antuitrin-G, Parke, Davis and Co.).
2. Contribution from the Dept. of Zoölogy, No. 172.

and Aberle (*1*) was used as a criterion of the depletion of the animals' bodily stores of vitamin A. This method postulates the persistent appearance of cornified epithelial cells as a sign of deficiency.

Experimental animals fed a Sherman A-free diet were given daily intraperitoneal injections of 0.4 cc. of Antuitrin Growth as soon as vaginal smears had shown persistent cornified cells for a week. These at once resumed their growth and became consistently larger and heavier than their controls which received no injections. The vaginal smears of the injected animals changed within three to five days after the beginning of injections from the heavily cornified cell types to smears composed of leucocytes and nucleated epithelial cells. Control animals on the A-free diet which received no injections showed constant cornified vaginal smears. In one case an animal was deprived of injections after having received injections for seven days. It began to lose weight at once and the vaginal smears began to revert to the typical cornified state in about five days after cessation of injection. This demonstrates that the growth and change of smear type in the experimental animals was due to the presence of the growth hormone. All the animals which received injections of the growth-promoting extract were more vigorous and more belligerant than controls which did not receive injections. The coats of the injected animals were, without exception, smoother, finer and thicker than those of the control animals. However, the experimental injected animals showed no pronounced improvement in the condition of xerophthalmia, or in the resumption of the ability to hold urine.

To our knowledge this is the first demonstration of the substitution of a growth-promoting substance (hormone) produced by the body for a vitamin known to be necessary for growth (vitamin A.) Aberle (*2*) in 1933 found no effect of injections of gonadotropic hormone extracted from placentas on the constant cornified smear of avitaminosis A, and as the extract used in these experiments had only traces, at most, of the sex-stimulating hormone, we feel that our results are not due to this factor. The fact that injections of the hormone failed to prevent or cure xerophthalmia resulting from vitamin A deficiency, or to cure incontinence of urine, points to the probability that some factor or factors are lacking in the substitution.

CONCLUSIONS

Albino rats which had their body stores of vitamin A depleted as judged by the persistence of cornified cells in vaginal smears for a period of seven days were given daily intraperitoneal injections of 0.4 cc. of antuitrin growth (Parke, Davis and Company). These showed decided gains in weights as compared with animals which were not injected.

The vaginal smears of injected animals changed from the cornified cell type (oestrus) typical of avitaminosis A, to those with leucocytes and nucleated cells (dioestrus).

The animals receiving injections were more vigorous, more pugnacious, and had finer, thicker, and smoother coats than noninjected controls.

The authors wish to express appreciation to Dr. Martha Kramer and Miss Bernice Kunerth of the Department of Foods and Nutrition of Kansas State College for their valuable assistance and advice and to Dr. E. H. Herrick for the animals and laboratory facilities.

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The Contents of Owl Pellets as Indicators of Habitat Preferences of Small Mammals.

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In studies of the habitat preferences of small mammals it has been found that an analysis of the contents of owl pellets is of some significance.

During the last six years (1930-'36) the writer has carried on considerable trapping for small mammals on mixed prairie, along streams, in sandy areas, on short grass, and on tall grass areas, to determine habitat preferences. Of course, owls in their hunt for food make no sharp distinctions in habitats. Their hunting and collecting of food is done over definite habitats only, broadly speaking. But by finding owl nests in areas predominantly of one general, environmental character, helpful information has been obtained.

As is well known, owls swallow their small mammal food whole; then the indigestible portions are formed into pellets in the stomach and regurgitated. These pellets are composed largely of hair and bones. And by means of these materials the owl food can be determined.

In the present study the pellets of barn owls (*Tyto alba pratincola*) were gathered from four nests from widely scattered areas and quite different environments. Barn owl nest No. 1 was in a large, hollow tree in a stream valley adjacent to prairies and cultivated fields, in the Fort Hays Pioneer Park in Ellis county. By means of nocturnal observation it was found that the owls from this nest sailed out over the open prairie and fields for most of their food. The soil of the area is somewhat sandy.

Barn owl nest No. 2 was in a barn on a farm place in Mitchell county, Kansas. The farm is on lowland; the soil is sandy. The immediate surroundings of the barn are farmyard, with its sheds, machinery, etc., barn lots, and small pasture lots. Farther away are larger grassy areas and cultivated fields. There is considerably more wooded land than farther west, in the neighborhood of nest No. 1.

Barn owl nest No. 3 was in a sand rock area not far from a stream, in Lincoln county. The soil is the most sandy of any of the four owl nest locations. There are trees along the sand rock outcroppings where the nest was located and along the stream.

Barn owl nest No. 4 was in Gove county, Kansas, in a chalk rock cliff in the chalky badlands. There were cultivated fields adjacent to the rocks where the nest was located. The soil is predominantly disintegrated limestone. Trees are scarce.

It is known by observation that the barn owl preferably hunts for food over open country.

Table I summarizes the species found by trapping on mixed prairie and by the analysis of owl pellets from the four nest locations. Figure 2 translates these numbers into an assumed one thousand animals per nest, to place the numbers for each species on a proportionate basis in all the nests.

Trans. Kansas Acad. Sci. 39, 1936.

It will be noticed in table No. II that the meadow mouse (Microtus) was the most numerous in nest No. 1, which had the most prairie land adjacent to it. It was next most numerous in nest No. 2, being more numerous than any other species in both No. 1 and No. 2.

TABLE I.—Species of Small Mammals and Birds Found in Barn Owl Pellets, from Four Nests, Compared with the Species Found on Mixed Prairie by Trapping. Nest No. 1, on Mixed Prairie; No. 2, Farm Yard, etc.; No. 3, on Sandy Bottomland; No. 4, on "Badlands."

SPECIES.	Trapping.	Nest No. 1.	Nest No. 2.	Nest No. 3.	Nest No. 4.
Microtus	246	912	210	109	13
Peromyscus	173	42	47	40	3
Reithrodontomys	42	39	20	18	3
Blarina	34	24	13	7	1
Cryptotis	61	14	7	4	0
Citellus	195	0	0	0	0
Lagomorphs	0	28*	2*	6*	2*
Neotoma	1	0	0	0	0
Mus musculus	0	8	25	5	0
Perognathus	0	87	50	168	22
Onychomys	0	8	1	1	2
Synaptomys	0	0	5	0	0
Dipodomys	0	1	0	1	3
Scalopus	0	0	8	18	0
Geomys	0	0	1	13	0
Rattus norvegicus	0	0	0	2	0
Mephitis	0	0	0	1*	0
Totals	754	1,175	399	398	49

* Pairs of lower jaws.

TABLE II.—The Data in Table I Made Comparable by Assuming a Thousand Skulls in Each Location. Nest No. 1, on Mixed Prairie; No. 2, in Farm Barn; No. 3, on Sandy Bottomland; No. 4, on Chalky Badlands.

SPECIES.	Trapping.	Nest No. 1.	Nest No. 2.	Nest No. 3.	Nest No. 4.
Microtus	330	780	550	270	270
Peromyscus	230	40	120	100	60
Reithrodontomys	60	30	50	50	60
Blarina	40	20	30	20	20
Cryptotis	80	10	20	10	0
Citellus	260	0	0	0	0
Lagomorphs	0	20	5	20	40
Neotoma	1	0	0	0	0
Mus musculus	0	7	60	20	0
Perognathus	0	80	130	420	440
Onychomys	0	7	3	2	40
Synaptomys	0	0	20	0	0
Dipodomys	0	8	0	2	60
Scalopus	0	0	30	50	0
Geomys	0	0	2	30	0
Rattus norvegicus	0	0	0	5	0
Mephitis	0	0	0	3	0

In nests 3 and 4, the pocket mouse (Perognathus) takes the place of Microtus as the largest single item in the diet of these owls. It is known from experience in trapping that the pocket mouse chooses only sandy or otherwise rocky soil. It was not found at all by trapping on mixed prairie upland.

The white-footed mouse (Peromyscus) appears to be most numerous on lowland sandy soil. The harvest mouse (Reithrodontomys) and the short-tailed shrew (Blarina) are the most nearly ubiquitous species in the four re-

gions, according to the owl pellets. The small short-tailed shrew (Cryptotis) is fairly evenly distributed, except in the chalk rock lands, where it was not found at all.

The kangaroo rat (Dipodomys) was found most abundantly in nest No. 4, which was in the most desertlike region; the mole (Scalopus) was found in the sandy lowlands, as was also the pocket gopher (Geomys). The house mouse was found most abundantly in nest No. 2, which was in a barn in a farm yard. But the brown rat (*Rattus norvegicus*) was not found at all in the farm yard nest. It was found, rather strange to say, in the pellets of nest No. 3, which was in the sand rock along a stream. Other habitat preferences may be seen by a study of table II.

It will be seen that, from the study of owl pellets collected from definite habitats, broadly considered, information of value on the habitat preferences of small mammals can be obtained.

Suggestions Regarding Preparation of Manuscripts for Publication in the Transactions of the Kansas Academy of Science.

DIVISION OF A MANUSCRIPT

Every article ordinarily consists of (1) the title, (2) the body of the paper, (3) the bibliography or literature cited, (4) the explanations of figures and plates, and (5) the figures and plates.

The figures and plates are separated from the rest of the manuscript by the managing editor and sent to an engraver, while the other items go to a printer to be set in type. Both are assembled at the time of printing.

Suggestions regarding each of these parts follow.

PREPARATION OF MANUSCRIPT

All of the manuscript should be typewritten, double (not single) spaced, upon one side of white paper approximately 8½ by 11 inches in size, of standard weight (not thin, slippery or shiny), with margins on all sides of at least an inch, with the pages numbered at the lower right-hand corner or center of top of page and arranged in order. The author sends the *original* typewritten copy to the editor and retains the carbon copy for reference and as a security against possible loss.

TITLE

The title should be written on the first page of the article, beginning at least one and one half inches below the top of the page. The subject should be as short as possible and should indicate exactly what the paper is about.

AUTHOR'S NAME

Centered below the title, put the name of the author or authors, followed by the school, city, and state, or simply by the city and state. (The location is to give some idea of where the author was at the time the work was done. The exact address may be found by looking in the list of members in the fore part of the volume.)

SPECIAL ACKNOWLEDGMENTS

In case there is a contribution number or any special statement of the subject, such as submitted in partial fulfillment of the requirements of a degree, or that special permission has been given for the publication of this article, that should be typed next but will appear in the article as a first footnote. Reference to it is made by a superior number[1] which is to be put either at the end of the title or at the end of the author's name, or after a particular author, depending on circumstances.

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If only one rank is present, they should all be typed ordinarily and centered in the middle of the page. If two or more ranks of subheadings are present, the primary ones should normally be in the center of the page and

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This constitutes the main portion of the manuscript. Careful and accurate preparation of the copy is the first and most important requirement. Changes from the original copy can be made only at considerable expense and are often not allowed. Spell out the names of elements or chemical substances, etc., where employed in the text. If certain words or portions of copy are to be *italicized,* so indicate in copy by underlining with a single line. Have your paper read over by one or more persons, if possible, both by persons who are acquainted with the subject matter and those that are not.

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Variation here is determined by the field and by the number of citations. The standard type of citation is as follows: Dahlberg (1) says . . . Citations should be numbered consecutively and the complete item be found in the literature cited at or near the end of the paper. In case there is only a small number of citations, it is sometimes just as convenient to have them as footnotes, in which case the superior figure should be used at the place where the citation is made. In some cases it is necessary to call attention to a specific page. The following form should then be used: Dahlberg (1, p. 34). In the literature cited the customary form in the different fields will normally be followed. In biological work the items will be the name of the author, exact title of article, name of publication in which the article was printed, volume of publication, pages, and date of publication.

Example: Dahlberg, E. H. Water content of maize. Bot. Gaz. 96:86-94. 1928.

In chemical work, the following form is customarily used: Name of author, journal, volume, year, and first page.

Where the item is a book rather than a magazine, the publisher, place and date of publication are usually given.

NUMBERING OF ILLUSTRATIONS

Figures should be numbered consecutively through each article, whether they are assembled in plates or not. Reference to the figures should occur in the body of the manuscript and the place where the figure is preferred should be indicated on the proof. It will not always be possible to put figures exactly there, but they are put as close as printing conditions permit.

EXPLANATION OF FIGURES AND PLATES

The explanations of figures and plates should be prepared by the author at the same time the rest of the manuscript is prepared, but on separate sheets of paper headed "Explanation of Figures and Plates." They should